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WILLIAM MORTON WHEELER[1]

William Morton Wheeler was born on March 19, 1865, at Milwaukee, Wisconsin. His interest in natural history was aroused at a very early age. While on a visit to his uncle in the Wisconsin country, when he was 9 years old, Wheeler saw a spider ensnare a moth in its web, and the explanation of this incident by his nature-loving uncle made so deep an impression on the boy that he became importunate for more nature lore. Subsequent observations of the habits of sexton beetles and burrowing wasps launched his career into entomological channels.

Young Wheeler was already too precocious an individualist to submit to the slow progress in public schools, and after what he later termed "persistently bad behavior" he was transferred to the near-by German academy, famous for the extreme severity of its discipline. Here under the "superheated atmosphere of German Kultur" were instilled habits of methodical persistence, which throughout his life were to become manifest in the careful completion of each undertaking. Characteristic of the attention to detail was the habit formed to read every word of a book, marking on page after page by vertical marginal lines those portions that appealed to him most strongly. At the Academy and the Normal School attached to it, Wheeler was given fundamental training in languages, philosophy, and science, a working equipment that influenced and facilitated his later activities. As a linguist he became remarkably proficient, fluently reading Greek, Latin, German, French, Italian and Spanish. His mastery of the classics enabled him to coin readily the multitude of euphonious terms that constantly embellished his writings.

[1]Published at the request of the Editorial Board.

While he was a student at the German Academy, Wheeler used to haunt the old museum of natural history at the school. In 1884 a miscellaneous collection of museum specimens was sent to the Milwaukee Exposition by Professor H. A. Ward, and Wheeler offered his services to aid in unpacking and arranging this material. The enthusiasm which he showed at this task resulted in his being appointed to the staff of Ward's Natural Science Establishment in Rochester, his duties consisting of the identification of specimens and the preparation of catalogues. A year and a half later, however, at the age of twenty he returned to Milwaukee to teach German and physiology at the city high school. The principal of the high school at that time was Dr. George W. Peckham, and Wheeler's intimate association with Peckham's studies of the habits of wasps and spiders, and the technique which he developed in preparing illustrations for Peckham's writings were undoubtedly molding influences at this stage of Wheeler's life. During this same year (1886) Wheeler was also under the influence of Professor C. O. Whitman and Dr. William Patten, the embryologist, who were in the Allis Lake Laboratory in Milwaukee. Patten, recently returned from Leukart's laboratory at Leipzig, inspired Wheeler to study insect embryology, on which he concentrated his spare time for the next four years, and all of his attention for the next two years following. During this period (1887) Wheeler left the high school to become custodian of the Milwaukee Public Museum, a position which he held until 1890. His embryological studies were carried out after museum hours, at home, where he had fitted up a small laboratory.

In 1890 Wheeler left Milwaukee to assist Professor C. O. Whitman at the newly established Clark University, and two years later (1892) he secured his doctorate in philosophy at the University, his dissertation being a "Contribution to Insect Embryology," now regarded as an outstanding entomological classic. During the same year Whitman left Clark University to become head of the department of zoology at the University of Chicago. Wheeler was appointed instructor in embryology under Whitman (1892), but was immediately given a year's leave of absence which enabled him to study in Europe, with Boveri at Würzburg, van Beneden at Liege, and at the Naples Zoological Station, where he held the Smithsonian table for 1893. Three years later he was appointed assistant professor at Chicago.

At this time there was an abrupt change in the course of his life. During the summer of 1899, following the death of Professor Norman of the department of zoology of the University of Texas, Wheeler was offered and accepted the opportunity to reorganize the department as professor of zoology. He remained there until 1903, and it was during this period, at the age of 35, that he became interested in the behavior and classification of ants, a group of insects which was the chief object of his study for the remainder of his life. In 1903 Wheeler became curator of Invertebrate Zoology at the American Museum of Natural History, which enabled him to complete a series of extensive studies on the taxonomy and behavior of ants. Five years later, when Wheeler relinquished this post, the Museum conferred on him the title of Honorary Fellow and Research Associate on Social Insects.

In September, 1908, he accepted the appointment of professor of economic entomology at Harvard University, and in 1915, when the Bussey Institution was reorganized as a graduate school for research in applied biology, he was selected as the dean, a position which he held until the transfer of the department of entomology to the Biological Laboratories in 1929. In 1926 he was appointed associate curator of insects at the Museum of Comparative Zoology, and from 1926 until his retirement from teaching in 1933, he was professor of entomology. The release from active classroom duty afforded greater freedom for research, and to his last day he was regularly at work in Cambridge on one or another of a multitude of projects, with alert mind and physically endowed with the same exuberance of energy that characterized his entire life.

In recognition of his achievements he was awarded honorary degrees by several universities: Sc. D. from the University of Chicago in 1916, from Harvard University in 1930, and from Columbia University in 1933; and LL. D. from the University of California, following his presentation of the Hitchcock lectures on social insects at the University in 1928. He received the Elliot Medal from the National Academy of Sciences and the third Leidy Medal from the Philadelphia Academy of Natural Sciences, and in 1934 was made an Officer in the Legion of Honor. He was also elected an honorary member of various societies: Société entomologique de France, Société entomologique Belgique, Royal Entomological Society of Lon-

don, Société zoologique de France, Royal Society of Edinburgh, Linnaean Society of London, and the Société Acadamique d'Histoire Internationale. He was an Honorary Fellow of the Entomological Society of America, and was its second president (1908); a fellow in the American Academy of Arts and Sciences, the American Academy of Arts and Natural History, the American Association for the Advancement of Science, the Washington Academy of Sciences, and the New York Academy; and was a member of the National Academy of Sciences, the American Philosophical Society, the American Morphological Society, the Cambridge Entomological Club, the American Society of Naturalists, the American Society of Zoologists, the Ecological Society of America, the Boston Society of Natural History, and the Psychological Association; and a Corresponding Member of the Academy of Natural Sciences of Philadelphia.

Professor Wheeler's reading was astounding in its extent and its varied nature. Assimilating even the details in his phenomenally retentive memory he was able to draw on this storehouse of information on every occasion. His reading encompassed not biology alone, but because of an early interest in behaviorism, he specialized in books on sociology and psychology. For lighter reading he enjoyed philosophy and metaphysics, as well as Greek and Latin classics in the original. It is not surprising that he had the reported distinction of being the most widely read member of his University.

Professor Wheeler was an active collector, not only of ants but of general zoological material as well, and he traveled to many parts of the world for this purpose. He made a special effort to collect thoroughly in regions that were little known entomologically, particularly in the tropics and subtropics of the New World: Mexico (1901, 1937), the Bahamas (1904), Puerto Rico (1906), Panama (1911, 1915, 1923, 1924), Costa Rica (1911), Guatemala (1911, 1935), Cuba (1913, 1924), British Guiana (1920), and the Galapagos Islands (1923). Two prolonged trips were made to Australia, in 1914 and 1932, and one to Hawaii in 1928. During the course of his several trips to Europe he did some insect collecting, and in 1925, when he was Exchange Professor at the University of Paris, he collected in Morocco and the Canary Islands. In this country he collected extensively, especially in the south and west; and in 1906 he collected fossil insects with several others at Florissant, Colorado.

Professor Wheeler's bibliography includes about 465 publications, totaling more than 10,000 pages. His papers published before 1900, numbering about 50, deal with a variety of subjects, but chiefly with insect embryology, systematics of the Dolichopodidae, and various studies on marine animals. The papers written after 1900 are concerned mainly with the taxonomy and behavior of the ants, though a number also deal with the social insects in general. Twelve of his publications appeared in book form. The earliest of these, issued in 1910 and entitled, "Ants," is another classic in entomological literature. His other books are: "Social Life Among the Insects" (1923), "Les Sociétés d'Insectes: leur origine, leur evolution" (1926), its American edition, "The Social Insects," (1928), "Reaumur's Natural History of Ants" (1926), "Emergent Evolution and the Development of Societies" (1928), "Foibles of Insects and Men" (1928), "Demons of the Dust, a Study in Insect Behavior" (1930), "Colony-Founding Among the Ants" (1933), "The Lamarck Manuscripts at Harvard" (1933), with T. Barbour as co-author, and "Sex Mosaics, Caste Mosaics, and other Anomalies Among Ants" (in press).

Wheeler is survived by his wife and their two children, Adeline and Ralph. To them and to his University from all quarters of the world have flowed messages of sympathy attesting the universal esteem in which professor Wheeler was held. As former President Lowell has fittingly said, "A great light has gone out of the intellectual firmament."

A. L. Melander
F. M. Carpenter.

A REVISION OF THE CLYTINI OF BOREAL AMERICA
(Cerambycidae, Coleoptera)

PART II[1]

GEO. R. HOPPING,
Vernon, British Columbia

Part I of the revisional work on Boreal American Clytini dealt with the *Clytus* group (Hopping, 1932, Ann. Ent. Soc. Am. XXV). In the present paper a study of the *Cyllene* group is presented. Considerable difficulty has been experienced in identifying species of the genus *Cyllene* Newman, because some of them apparently are in a transitional state. Included in the material for study were many misidentifications, indicating a need for a clear-cut definition of the species. In a few cases, final decisions cannot be made until the biologies of the species in question are known. Investigation has shown that the genitalia of *Cyllene* are of little use for the separation of species and other characters have to be relied upon.

The writer realizes that an ideal revision of a group should not stop at a man-made geographical boundary. It would be desirable to include the *Cyllene* and *Ochraethes* of Mexico, Central and South America, and islands. Although most of the species of *Cyllene* and *Ochraethes* have been examined as well as the type species of every genus dealt with, it was considered that the species from south of the Mexican line were not represented in series sufficient for revisional purposes and therefore this paper is confined mainly to boreal America.

The *Cyllene* group of boreal American Clytini includes the genera *Cyllene* Newman, *Placosternus* n. gen., *Megacheuma* Mickel, *Glycobius* LeConte, *Calloides* LeConte, *Sarosesthes* Thomson, *Tylcus* Casey, *Ochraethes* Chevrolat, and the subgenus *Triodoclytus* Casey.

Megacheuma was described in a rather obscure paper and was overlooked in Part I. Recently, *Ochraethes sigmoideus* Bates, from Texas, has been submitted by E. R. Tinkham. In view of additions and changes, it becomes necessary to rearrange the generic key to the *Clytini*.[2]

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[1]Contribution from the Division of Forest Insects, Dominion Entomological Branch, Department of Agriculture, Ottawa.

[2]Acknowledgments additional to those in Part I are as follows: E. G. Linsley, University of California at Los Angeles; M. H. Swenk, University of Nebraska; C. E. Mickel, University of Minnesota; W. J. Brown, Dominion Entomological Branch, Ottawa; H. P. Loding, Mobile, Alabama.

GENERIC KEY

1. Antennae with some segments spined distally 2
   Antennal segments without distal spines 5
2. Prosternal intercoxal piece declivous or flat 3
   Prosternal intercoxal piece perpendicular ..... (p. 440) **Cyllene**
3. Margins of elytra not sinuous 4
   Margins of elytra sinuous ..... (p. 451) **Tylcus**
4. Anterior portion of mesosternum suddenly declivous and strongly, transversely concave below the declivity ..... (p. 449) **Glycobius**
   Anterior portion of mesosternum feebly declivous, oblique, (p. 446) **Megacheuma**
5. Face without carinae 6
   Face with Y-shaped or bicarinate ridge ..... **Xylotrechus** Chevrolat
6. Pronotum with transverse carinae 7
   Pronotum without transverse carinae 8
7. Antennae 11-segmented ..... **Neoclytus** Thomson
   Antennae 12-segmented ..... **Euryscelis** Chevrolat
8. Forepart of mesosternum declivous, oblique or nearly flat 9
   Forepart of mesosternum perpendicular ..... (p. 447) **Placosternus**
9. Base of thorax as broad as or broader than apex; antennal segments never much more than four times longer than broad 10
   Apex of thorax broader than base; some of antennal segments six times longer than broad ..... **Clytoleptus** Casey
10. Metepisternum not over three times longer than broad 11
    Metepisternum about four times longer than broad 12
11. Plane of the face elevated above the front margins of the eyes, (p. 450) **Calloides**
    Plane of the face not elevated above the front margins of the eyes, **Clytus** Laicharteg
12. Terminal palpal segments much longer than broad ..... (p. 452) **Sarosesthes**
    Terminal palpal segments equilaterally triangular or nearly so 13
13. Elytra with undulant bands; antennae not appreciably tapered; apices of elytra truncate-emarginate ..... (p. 453) **Ochraethes**
    Elytra without undulant bands; antennae appreciably tapered; apices of elytra usually not truncate, sub-genus ..... (p. 454) **Triodoclytus**

Group **Cyllene**

Members of this group display the following characters:

The *head* is about three-fifths the breadth of the thorax, the face short and oblique (except *Tylcus* which has the face nearly perpendicular), the *vertex* usually broadly elevated below the antennae, bisected by the *epicranial stem* which is often deeply impressed between the antennae. The *epicranial arms* are usually clearly defined, situated well forward, reducing the *front* to a broad triangular area. The *clypeus* is large, flat, the distal margin straight, transverse, the lateral margins oblique. The *labrum* is sinuate or emarginate distally, with arcuate lateral margins. The *mandible* is stout, triangular in cross-section, strongly concave on the inner face, grooved on the cutting edge, rather strongly incurved near the tip. The *mentum* has strongly arcuate lateral margins, the distal margin straight or slightly arcuate. The *ligula* is Y-shaped, the lobes rounded at the tips. The *palpal segments* are stout, the terminal segments triangular as in *Ochraethes* to somewhat elongate as in *Sarosesthes*. The eyes are deeply emarginate (except *Tylcus*), rather finely granulate (1000 to 1500 facets per sq.

mm.). The *antennae* are stout, filiform to sub-serrate, of moderate length, longer than the body only in the males of a few species.

The *prothorax* is sub-cylindrical, usually broader than long, moderately to strongly arcuate laterally, the apical and basal margins reflexed, the *pronotum* moderately inflated to somewhat flattened, more or less evenly arcuate at the sides. The *prosternum* is generally broader than long (excluding the intercoxal piece) although in many species the lateral margins are feebly indicated. The *prosternal intercoxal piece* is broad to very narrow, variously modified at the tip. The *proepimeron* is triangular, excluding the dorsal arm.

The *mesosternum* is slightly declivous to perpendicular anteriorly, the intercoxal piece flat to gibbous, truncate to emarginate at the tip. The *mesepisternum* is approximately an equilateral triangle, the sides slightly arcuate, concave dorso-ventrally to almost flat. The *mesepimeron* has the cephalic and caudal margins sub-parallel, emarginate, the ventrad margin at right angles to them and the dorsad margin oblique.

The *metasternum* is broad, moderately to strongly convex transversely, the front margin between the coxae rounded, but usually overlapped by the mesosternum, the lateral margins almost straight, the mid-suture well defined. The *metepisternum* is broad, as in *Cyllene* and *Calloides*, to narrow as in *Sarosesthes* and *Ochraethes*, divided by a ridge into an upper portion bearing the wing process, and the main lower portion. The *metepimeron* is narrow, more or less wedge-shaped and is divided into an upper and lower part by an impressed line. The posterior end terminates in a blunt to acute point.

The *abdominal intercoxal piece* is usually broad and rounded at the tip.

The *elytra* vary from sub-parallel to quite strongly tapered, the apices truncate to almost rounded and often spined.

The *legs* are moderate in length, the pairs not excessively unequal in size, the hind thighs moderately clubbed, seldom extending to the elytral apices.

The group comprises insects of large size (up to 26 mm. in length), usually heavily vestitured and ornamented with yellow or gray fasciae or spots.

Genus **Cyllene** Newman

1840, The Entomologist, London, 7.

Thomson, 1860, Classif. Ceramb., 215. Lacordaire, 1869, Gen. Col. IX, 62. Leconte, 1873, Smith. Misc. Coll. XI (264), 318. Provancher, 1877, Faune Ent. Canada I, 593. Horn, 1880, Trans. Amer. Ent. Soc. VIII, 134. Leconte and Horn, 1883, Classif. Col. N. Amer., 304. Leng, 1887, Ent. Amer. II, 194. Casey, 1912, Mem. on Col. III, 351. Hopping, 1932, Ann. Ent. Soc. Amer., XXV, 533.

Syn. *Megacyllene* Casey, 1912, Mem. on Col. III, 348.

Type *C. spinifera* Newman, designated by Chevrolat, 1860, Ann. Soc. Ent. Fr., 453; type *C. spinifera* Newman cited by Thomson, 1864, Syst. Ceramb., 184; type *C. signifera* cited by Casey, 1912, Mem. on Col. 348. This last is apparently intended for *spinifera*.

Additional characters: The prothorax is transversely excavated at the base. Antennal segment 3 is equal in length to 4. Segments 5 to 10

are subserrate, 3 to 6 spined distally, and with pencils of bristles basad of each spine and also on segment 2. The mesosternum is almost perpendicular in front to moderately steeply declivous, gibbous behind the declivity. Most species have well-developed sub-sutural carinae.

CYLLENE, SPECIFIC KEY

1. A prominent, shining, sub-sutural carina on each elytron 2
   Elytra without sub-sutural carinae 7
2. Elytral apices not spined or feebly so 3
   Elytral apices strongly, acutely spined ..... (p. 441) **antennatus**
3. Some of elytral pale areas more than one-half the breadth of the dark areas between 4
   Elytral pale bands less than one-half the breadth of the dark areas between .. 8
4. Elytral pale bands 3, 6 and 7 much broader than 2, 4 or 5; legs rufuous, (p. 443) **snowi**
   Elytral bands not as above 5
5. Truncature of elytral apices pronounced, external and internal angles shortly and bluntly prolonged 6
   Truncature of elytral apices feeble, the external angle not prolonged into a spine, the inner angle rounded ..... (p. 445) **zuniana**
6. None of elytral bands coalesced to form solid flavous areas, the pale bands as broad as or broader than the dark bands between ..... (p. 445) **infausta**
   Two or more bands often coalesced to form solid flavous areas, but when all pale bands separate, narrower than dark bands between .... (p. 444) **decora**
7. Pale pubescence completely covering pronotum and elytra, obscuring the bands ..... (p. 445) **lutosa**
   Pronotal and elytral bands not obscured as above ..... (p. 446) **angulifera**
8. Pale pubescence of metepisternum not or narrowly divided at middle; antennae of male shorter than body ..... (p. 442) **robiniae**
   Pale pubescence of metepisternum broadly divided to form two widely-separated spots; antennae of male longer than body ..... (p. 442) **caryae**

Cyllene antennatus White

C. antennatus White, 1848, Nomen. Col. Ins. in Brit. Mus. VIII, 252.
syn. *eurystethus* Leconte, 1858, Proc. Acad. Nat. Sci. Phila., 82.

Length, 10–23 mm.; breadth, 3–7.5 mm. The color is brown with a somewhat silky sheen. Beneath, it is uniformly and rather densely covered with decumbent gray pubescence, with the spots of the metepisternum somewhat differentiated. The pale areas of the elytra are gray and the pronotum is densely covered with decumbent gray pubescence. The face is nearly twice as broad as long, broadly elevated. The hind angles of the pronotum before the basal excavation are feebly tuberculate. The antennal spines are long and acute and the scutellum is triangular. The antennae of the male are longer than the body.

This species is more closely related to the type of the genus than any other from boreal America. Fifteen males and ten females were examined from California, Lower California, Arizona, and Texas. Type locality, "W. Coast of America." Host: *Prosopis;* also recorded from Acacia (Craighead, 1923, N. A. Ceramb. Larvae, Can. Dept. of Agr. Bull. 27, n. s., 53). Type in the British Museum.

Dr. Horn stated "*C. antennatus* White = *eurystethus* Lec." (1880, Trans. Am. Ent. Soc. VIII, 135.)

Cyllene robiniae Forster

(Plate I)

C. robiniae Forster, 1771, A Cat. of the Animals of N. A. London, 43.
(syn. *flexuosa* Fabricius, 1775, Syst. Ent., 191.)
(syn. *angulata* Fabricius, 1775, Syst. Ent., 192.)
(syn. *pictus* Drury, 1770, Illust. of Nat. Hist., 91.)[3]

Length, 11.5–28 mm.; breadth, 3–6 mm. The ground color is black, the antennae dark brown, the legs reddish brown. The ornamentation is usually yellow. Beneath there are yellow pubescent patches on the prosternum, the posterior part of the metepisternum, laterally on the front and hind margins of the metasternum, on the metepisternum, except at the middle, the posterior part of the metepimeron, and laterally on the posterior margins of the abdominal segments. The basal excavation of the prothorax is feeble. The elytral apices are obliquely truncate, with the angles scarcely produced.

This species has the scutellum more broadly rounded than in *antennatus*, and the antennal spines, although acute, are much shorter. The antennae do not differ appreciably between the sexes. Twenty males and thirty-eight females were examined from Maine, New Hampshire, Massachusetts, Pennsylvania, New York, Indiana, Illinois, Ohio, Kansas, Nebraska, Minnesota and Ontario. Host: *Robinia pseudacacia* L. Mr. K. G. Blair says a so-called type is in the Hunterian Museum, Glasgow. The true type is said to be in the Drury collection.

Cyllene caryae Gahan

(Plate I)

C. caryae Gahan, 1908, Ann. Mag. Nat. Hist. 1, 141.

Length, 10–19 mm., breadth, 3–6.5 mm. The ground color is black, the antennae dark brown to black, the legs brown, usually darker than in *robiniae*. The dorsal ornamentation is usually yellow except the second or W-shaped band which is nearly always gray. The ornamentation beneath is about as in *robiniae* except that some of the spots are gray. The face is more strongly elevated medially. The elytra are noticeably tapered, apices sinuate truncate, the angles of truncature feebly produced. The antennal spines are rather short and robust.

Thirty-seven males and twenty-seven females were examined from New York, Massachusetts, Pennsylvania, Maryland, Ohio, Illinois, Iowa, Kansas, Minnesota, and Texas. Other localities given are New Jersey, Connecticut, Indiana, Nebraska, Ontario, West Virginia, and Durango, Mexico (Dusham, 1921,

[3]The reason *pictus* Drury does not take precedence over *robiniae* Forster is explained by Dusham, 1921, The Painted Hickory Borer, Cornell Agr. Exp. Sta. Bull. 407.

Cornell Agr. Exp. Sta. Bull. 407, 181). Hosts: *Hicoria, Toxylon, Fraxinus, Celtis, Vitis, Morus* (Craighead, 1923, N. A. Ceramb. larvae, Can. Dept. Agr. Bull. 27, N. S., 52).

For over forty years this species was known as *C. pictus* Drury, which is undoubtedly a synonym of *robiniae* Forster, although several workers knew that the hickory-feeding species and the locust-feeding species were distinct (Dusham, 1921, reference above). The following differences between the two species have been noted by various entomologists:

1. The hind thighs of *caryae* males extend behind the tip of the abdomen; not so in *robiniae*.
2. In *caryae* the W-shaped band rarely joins the one in front at the suture; in *robiniae* this band nearly always joins the one in front along the suture.
3. The male coarse pronotal punctation in *caryae* is much more extensive than in the male of *robiniae* in which it is mainly confined to the anterior part.
4. The upper side of the abdomen of *caryae* is reddish, the anal segment black; in *robiniae* all black.

Horn (1880, Trans. Am. Ent. Soc. VIII, 134) mentions the second joint of the hind tarsus of *caryae* as being glabrous at the middle, but this does not seem to be a reliable character for separating the two species. The type of *caryae* is in the British Museum.

Cyllene snowi Casey

(Plate I)

C. snowi Casey, 1912, Me. on Coleop. III, 353.

Length, 12–18 mm.; breadth, 4–7 mm. The ground color is dark brown to black, the legs and antennae reddish-brown. The ventral side is rather densely gray or yellow pubescent, in the males somewhat more condensed on the posterior portion of the mesepisternum, and laterally on the hind coxae. The females are quite solidly yellow pubescent beneath and are considerably broader than the males. The dorsal ornamentation of the female is yellow; in the male the fasciae of the head and pronotum are yellow but of the elytra, 1, 3, 6 and 7 are gray, the others yellow. The prothorax is sprinkled with gray pubescence, the basal excavation feeble. Both male and female antennae are shorter than the body, the antennal spines short and robust. The prosternal intercoxal piece is somewhat dilated at the tip and a little produced, overhanging.

Seven males and two females were examined from Arizona and New Mexico (F. H. Snow, J. S. Kusche, and D. K. Duncan). Type locality, Arizona (Oak Creek Canyon, elev. 6,000 ft.). Host: *Robinia*, (Craighead label). Type in the Casey collection, Washington, D. C.

Cyllene decora Olivier
(Plate II)

C. decora Olivier, 1795, Entomologie IV, Paris, 63.
ab. *charus* Say, 1835, Boston Journ. Nat. Hist. I, 193.
ab. *mediana* Aurivillius, 1912, Junk. Col. Cat. (39), 384.
ab. *horni*, Aurivillius, 1912, Junk. Col. Cat. (39), 384.
ab. *castelnaui*, 1912, Junk. Col. Cat. (39), 384.
ab. *genitiva* Casey, 1912, Mem. on Col. III, 355.
ab. *solida* Casey, 1912, Mem. on Col. III, 355.
ab. *kansana* Casey, 1912, Mem. on Col. III, 355.

Length, 12–23 mm.; breadth, 5.5–8 mm. The ground color is black, the ornamentation ochraceous, occasionally lemon yellow, the legs black, the antennae dark brown to black. Beneath, the yellow pubescence is condensed on the prosternum (gray on the intercoxal piece), the hind part of the mesepisternum, on most of the metasternum and metepisternum except at the middle, laterally on the hind coxae and broadly on the lateral posterior margins of the abdominal segments. The antennal spines are short and robust. The hind margin of the prosternal intercoxal piece is slightly projected into an overhanging lip. The basal excavation of the prothorax is quite strongly developed.

Forty males and twenty-nine females were examined from North Carolina, Alabama, Illinois, Missouri, Kansas, Nebraska, Minnesota, Ohio, Iowa, and Texas. Type locality, "Environs of New York."

This is the most variable species of *Cyllene* with respect to elytral pattern (Plate II). As a rule it can be readily identified by its large size, the coalescence of the pronotal yellow fasciae with the solid yellow vestiture on the side of the pronotum, the densely black areas between the pale fasciae, and the black legs. Mr. K. G. Blair kindly forwarded a specimen from the British Museum which agrees in all essentials with one from the Olivier collection, the only difference being that band 4 is complete instead of abbreviated as in Olivier's figure. Dr. R. Jeannel says in a letter that the type of *decora* is not in the collection of the Natural History Museum, Paris, and that it probably was destroyed more than one hundred years ago since there is no mention of it in the catalogues of the old museum collection.

The various aberrations which have been named are shown in Plate II. Specimens of *kansana* and *genitiva* examined were compared with the types by Mr. W. S. Fisher. In Leng's check list, the indication that Horn's *decora* var. fig. 86, fig. 8c and fig. 8d were cited in error, is apparently incorrect. As described and figured by Horn (1880, Trans. Am. Ent. Soc., VIII, 138, Pl. II) they are undoubtedly aberrations of *decora* Olivier.

Cyllene infausta Leconte

(Plate I)

C. infausta Leconte, 1850, Journ. Acad. Nat. Sci. Phila (2), 17.

Length, 11–18.5 mm.; breadth, 3.5–6 mm. The ground color is black, the bands lemon yellow to ochraceous. The fasciae are placed as in *decora* but they are much broader in comparison to the dark areas. In *infausta* the margins of the elytra are straighter and the average size is much smaller than in *decora*. Although some specimens of *infausta* have the bands greatly expanded, no specimens have been seen where two bands were completely coalesced. The legs are black (occasionally reddish-brown) the tarsae sometimes paler. The antennae are black basally to brown distally. Beneath, the yellow pubescence is practically entire, less dense in the central portion of the metasternum and medially on the abdominal segments.

It is difficult to point out any structural differences between this species and *decora*, and rearing experiments may prove it to be only a variety of the latter species. However, it readily can be distinguished from *decora* by the elytral pattern and general form and should be retained as a distinct species for the present. Eleven males and nine females were examined from South Dakota, Minnesota, Nebraska, and New Mexico. Type in the LeConte collection, Cambridge, Massachusetts.

Cyllene zuniana Casey

(Plate I)

C. zuniana Casey, 1912, Mem. on Coleop. III, 353.

Length, 11.5–13 mm.; breadth, 3.5–4 mm. This rather small species has the ground color black, the light bands either cinereus (male) or yellow (female), with reddish-brown legs and antennae. The sexual punctation of the pronotum (male), is very coarse, the posterior excavation of the prothorax feeble. The flavus bands of the head and pronotum are about as in *snowi*. The elytral pale bands are arranged as in *snowi*, but the first five do not differ markedly in breadth, 6 being broader than the rest. The feeble elytral truncature has the inner angle somewhat rounded. The ventral pubescence is not so dense as in *snowi*.

A male and a female were examined from New Mexico, the male compared with the type by Mr. W. S. Fisher. Type locality, New Mexico (Magdalena Mts.). Type in the Casey collection, Washington, D. C.

Cyllene lutosa Leconte

(Plate I)

C. lutosa Leconte, 1861, Proc. Acad. Nat. Sci. Phila., 356.

Length, 10.5 mm.; breadth, 3.3 mm. This small species can be

easily recognized because it is the only *Cyllene* having the body entirely and uniformly covered with dense yellow pubescence. The legs and antennae are pale reddish-brown. The sub-sutural elytral carinae are wanting, which immediately sets it apart from *decora* with which it has been associated by previous workers. It is difficult to understand how *lutosa* was ever placed as an aberration of *decora*.

Three females were examined from Kansas (Riley County, Douglas County and Baldwin). Type locality, "Kansas, near the Rocky Mountains." Type in the LeConte collection, Cambridge, Massachusetts.

Cyllene angulifera Casey

(Plate I)

C. angulifera Casey, 1912, Mem. on Col. III, 354.

Length, 10.5–19 mm.; breadth, 3.3–6.5 mm. This species presents intermediate characters between *Cyllene* and *Megacheuma*. Some specimens exhibit faint traces of sub-sutural carinae as in typical *Cyllene*. In *Megacheuma* these seem to have disappeared entirely. The basal excavation of the prothorax is likewise feeble as in *Megacheuma*, but the prosternal intercoxal piece is perpendicular at the tip as in *Cyllene*.

The ground color is light to dark brown, the ornamentation either yellow or cinereus, the legs and antennae reddish-brown. The antennae are much shorter than the body and do not differ greatly between the sexes. The face is not so convex as in most Cyllene and the antennal spines are small but acute.

This species has been called *infausta* by some collectors. The late Mr. F. S. Carr probably took more of this species than any other collector. It occurs on golden-rod in the fall. Twenty males and eighteen females were examined from Alberta, Manitoba, South Dakota, and Kansas, one specimen compared with the type by Mr. W. S. Fisher. Type locality, Kansas. Type in the Casey collection, Washington, D. C.

Genus **Megacheuma** Mickel

1919, Ent. News, XXX (7), 198.

Leconte, 1873, Smith. Misc. Coll. (264) II, 197. Horn, 1880, Trans. Am. Ent. Soc. VIII, 136. Casey, 1912, Mem. on Coleop. III, 351. Leng, 1920, Cat. Col. Bor. Am., 277. Hopping, 1932, Ann. Ent. Soc. Am. XXV, 543.

Type by original designation *M. melanosticum* Mickel.

The face is flat, the plane of the face elevated above the anterior ocular lobes. The antennae are quite strongly serrate. The basal excavation of the prothorax is rather feeble. The prosternal intercoxal piece is evenly and gradually declivous. The mesepisternum is almost flat. The first segment of the hind tarsus is longer than the remainder.

This genus is near *Cyllene* but can be distinguished by the key character, the mesosternum much less strongly declivous, the mesepisternum less concave and by having five instead of seven elytral bands.

Megacheuma brevipennis (Leconte)
(Plate III)

M. brevipennis (Leconte), 1873, Smith. Misc. Coll. 264, II, 197.
syn. *melanosticum* Mickel, 1919, Ent. News XXX (7), 199.

Length, 13–16 mm.; breadth, 4–4.5 mm. The ground color is brown to black, the legs dark brown to black. The antennae are black basally to light brown distally. The under surface and legs are evenly covered with short gray vestiture and more condensed yellow vestiture on the hind portion of the mesosternum, front and hind portions of the metasternum and metepisternum and laterally, broadly, on the abdominal segments. The antennae are much shorter than the body, most of the segments not over twice longer than broad, 3–6 bearing short acute spines, 3 equal to 4, shorter than 5. The disc of the pronotum has several rough elevations near the middle and at the sides causing a very uneven surface.

This species is easily recognized by its superficial resemblance to *Xylotrechus* but with the *Cyllene* type of ornamentation. Five specimens were examined, one, the allotype male of *melanosticum* kindly sent by M. H. Swenk, type locality, Big Horn basin, Wyoming (University of Nebraska collection). Of the other four, three are females, one from Baker, Nevada (E. G. Linsley), one from Parowan, Utah (W. Knaus), compared with Leconte's type of *brevipennis* by Mr. H. C. Fall, and one from Malheur Lake, Oregon (W. J. Chamberlin). The ground color is dense black and the yellow bands are much narrower than in the figure (Plate III). One of the females also has bands narrower than the others. The type locality of *brevipennis* is Utah. The type is missing from the Leconte collection.

Genus **Placosternus** n. gen.

Type *Placosternus difficilis* (Chevrolat)

This genus previously has been included in *Cyllene*. In addition to unspined antennae, it differs from *Cyllene* and others of the group by having the face longer than broad, markedly oblique, strongly elevated medially into a high ridge with sloping sides. The clypeus is short in proportion to the breadth (as 1 is to 5). The prosternal intercoxal piece is as wide as the fore coxa or wider, strongly dilated at the tip and produced into a broad, spatulate, thin plate usually covering the anterior part of the mesosternum. The posterior margin of the pronotum is strongly produced into an overhanging lip, a character

which is feebly evident in *Cyllene*. The pencils of bristles on antennal segments 2–6 are well developed as in *Cyllene*. The scutellum is triangular, the sub-sutural elytral carinae prominent. The distance between the eyes in front is less than twice the depth of the ocular emargination, whereas in *Cyllene* this distance is twice the ocular emargination or more. The elytra are strongly tapered, the apices acutely spined. The hind thighs are also spined. Apparently two species of this genus extend north of the Mexican boundary and a third species, *crinicornis* Chev., may occur here. The genus is primarily a tropical one.

PLACOSTERNUS, SPECIFIC KEY

Pronotum with three transverse pale bands.....(p. 449) **erythropus**
Pronotum with four transverse pale bands.
  Prosternal intercoxal piece with dilated portion occupying nearly half of it, dilation extreme.....(p. 448) **crinicornis**
  Prosternal intercoxal piece with dilated portion occupying much less than half of it, dilation moderate.....(p. 448) **difficilis**

Placosternus difficilis (Chevrolat)

(Plate III)

P. difficilis Chevrolat, 1862, Ann. Soc. Ent. Fr., 263.
  syn. *reducta* Casey, 1912, Mem. on Col. III, 351.
  syn. *filicornis* Casey, 1912, Mem. on Col. III, 352.

Length, 10–17 mm.; breadth, 3.5–5 mm. The ground color is black, legs and antennar reddish-brown. The under surface is moderately densely covered with silky gray pubescence, except on the abdomen, and with more condensed yellow vestiture on the pro-epimeron, mesepisternum except the anterior margin, laterally on the front and hind margins of the metasternum, on the metepisternum except at middle, laterally on the hind coxae (gray instead of yellow) and laterally on the hind margins of the abdominal segments. The basal excavation of the prothorax is at the sides only with a distinct angle before the excavation. The prosternal intercoxal piece is as wide as the fore coxa, and three-fifths the length of the prosternum, almost straight across the tip but with the sides of the dilated portion rounded.

This species has been known to most collectors as *crinicornis*, but it differs from the latter as noted in the key and in having darker legs and antennae. Proportionally the prosternal intercoxal piece is less dilated, not projected so far behind in *difficilis* as in *crinicornis* and *erythropus* and the distance between the coxae is not greater than the coxal breadth. Of *difficilis*, fifteen males and seventeen females were examined from California, Texas and Cuba. Type locality, Havana, Cuba. Type in the British Museum.

Placosternus crinicornis (Chevrolat)

P. crinicornis Chevrolat, 1860, Ann. Soc. Ent. Fr. (3) VIII, 460.
  ab. *sanguinipes* Chevrolat, 1860, Ann. Soc. Ent. Fr. (3) VIII, 360.
  syn. *similiguttata* Chevrolat, 1861, Ann. Soc. Ent. Fr. (4) 1, 380.

Length, 13–14 mm.; breadth, 4.5–5 mm. The markings of this species are practically the same as in *difficilis*. In addition to the key character, and differences noted under *difficilis*, the legs, antennae and exposed parts of the under surface are more rufous in *crinicornis* than in *difficilis*.

There are three specimens before me, two males (Port-au-Prince, Haiti, and Cayenne, French Guiana) and a female from Tole, Panama, determined by Mr. K. G. Blair. Type locality, near "Grenade," which probably refers to the island of Grenada in the Windward Island group. Type in the British Museum.

Placosternus erythropus (Chevrolat)

P. erythropus Chevrolat, 1835, Col. Mex. Cent. I. Fasc. 4e nr. 70.
syn. *mexicanus* Castelnau & Gory, 1835, Monogo, d. g. Clytus.
ab. *variegata* Castelnau & Gory, 1835, Monogo, d. g. Clytus, p. 6, t. 2, f. 4.

Length, 14–20 mm.; breadth, 4.5–6.4 mm. The markings are as in the two preceding species but *erythropus* is easily recognized by the key character and by the shape of the prosternal intercoxal piece. It is more broadly dilated behind the coxae and more evenly and broadly emarginate posteriorly, than in *difficilis* or *crinicornis*. Beneath, the exposed parts are usually black instead of reddish-brown as in *crinicornis*.

A female was examined from Alpine, Texas (H. P. Loding), one female without locality label (E. G. Linsley), and a female and three males from Mexico (submitted by C. E. Mickel). Another female from Mexico was determined by Mr. K. G. Blair. Type in the British Museum.

A third species, as yet undetermined, belonging to this genus, is represented by examples from Hawaii, Tahiti, and Marquesas.

Genus **Glycobius** Leconte

1873, Smith. Misc. Coll. 265, II, 319.

Lacordaire, 1869, Gen. Col. IX, 64. Provancher, 1877, Faune Ent. Canada I, 594. Leconte and Horn, 1883, Classif. Col. N. Amer., 304. Leng, 1887, Ent. Amer. II, 195. Casey, 1912, Mem. on Col. III, 349, 356. Hopping, 1932, Ann. Ent. Soc. XXV, 533.

Monotypic, type cited by Casey, 1912. *Clytus speciosus* Say. Mem. on Col. III, 349.

The antennae are strongly compressed, subserrate. The sides of the terminal segment of the maxillary palpus are sub-parallel. The prosternum is a little over twice broader than long, the intercoxal piece about half the coxal breadth, moderately declivous toward the tip. The intercoxal piece of the abdominal segment is extremely broad and rounded. The mesosternal intercoxal piece is truncate at the tip and the scutellum is evenly and broadly rounded posteriorly. The prothorax is one and one-half times broader than long.

This genus is more closely related to *Plagionotus* Mulsant of Europe than to any of the North American genera. It differs from the latter in the narrower prosternum, the terminal segments of the palpae not triangular as in *Plagionotus* and in the greatly compressed antennae.

Glycobius speciosus Say

(Plate III)

G. speciosus Say, 1828, American Entomology III, 53.

Length, 20–27 mm.; breadth, 7–9 mm. The ground color is black, the legs yellow, the antennae black. The ornamentation is bright yellow. The under surface has dense yellow vestiture on the forepart of the prosternum, a spot on the back part of the mesepisternum, on the metasternum and metepisternum, and broadly on the abdominal segments except the basal margins. The pronotal punctation of the females is relatively fine and uniform, of the males, coarse, dense, and not uniform. The species is easily recognized by its large size and characteristic elytral pattern.

Three males and five females were examined from Maine, New York, New Hampshire, Massachusetts, and New Jersey. Host: Sugar maple (*Acer saccharum* Marsh).

Genus **Calloides** Leconte

1873, Smith. Misc. Coll. 265, II, 319

Type designated by Casey, *Clytus nobilis* Say, 1912, Mem. on Col. III, 349. This is an error. The type of the genus is *Clytus nobilis* Harris, not Say.

The prosternum is seven-tenths as long as broad, the intercoxal piece very narrow, the sides convergent. The face is very flat, the plane of the face notably elevated above the ocular lobes. The preclypeal sulcus is feebly impressed. The area enclosed by the eye emargination is deeply concave. The antennae are not longer than half the body length, the individual segments rather strongly tapered from apex to base, 1–4 round in cross-section, 5–11 somewhat compressed.

C. nobilis is placed in Plagionotus by some European entomologists, but it is not strictly congeneric with the type species of *Plagionotus*, *P. detritus* L. The prosternum of *Calloides*, as exemplified by the type species *nobilis*, is longer in proportion to the breadth than in *Plagionotus*, the plane of the face strongly elevated above the anterior ocular margins, feebly so in *detritus*. The abdominal intercoxal piece in *nobilis* is much more broadly rounded than in *detritus*, and the scutellum much broader in proportion to the length. These differences make it advisable to retain *Calloides* as a distinct genus.

SPECIFIC KEY

Prosternum broadly, deeply, transversely impressed at the middle.....lorquini
Prosternum not impressed at the middle.....nobilis

Calloides nobilis (Harris)

(Plate III)

C. nobilis (Harris) 1836, Trans. Hartford Nat. Hist. Soc. I, 84, var. *regalis* Chevrolat, 1860, Ann. Soc. Ent. Fr. (3), 488, var. *mormonus* Schaeffer, 1911, Journ. N. York Ent. Soc. XIX, 124, syn. *muliebris* Casey, 1912, Mem. on Col. III, 358, syn. *coloradensis* Casey, 1912, Mem. on Col. III, 358.

Length, 20–24 mm ; breadth, 6.5–7.5 mm. The ground color is black, head, thorax, and under surface black, the elytra dark brown The antennae are black basally to dark brown distally. The ornamentation is yellow, the under surface sparsely covered with gray pubescence with more condensed yellow patches on the mesosternal intercoxal piece, and narrowly, laterally on the posterior margins of the first and second abdominal segments. The legs are only moderately robust. It is easily recognized by its large size and typical form as illustrated.

The variety *mormonus* Schaef. is the same as *regalis* Chev., which differs from *nobilis* only in the markings. One specimen of *mormonus* from Logan, Utah, was examined. This was compared with the type of *mormonus* by Mr. W. S. Fisher (U. S. National Museum collection) and with the type of *regalis* by Mr. K. G. Blair (British Museum collection). In *regalis* the basal bands extend two-thirds across the elytra; the second band almost to the lateral spot, and the third, fourth and apical bands extend clear across.

Calloides lorquini (Buquet)

(Plate III)

C. lorquini Buquet, 1859, Ann. Soc. Ent. Fr. 3, VII, 629.

Length, 21–27 mm.; breadth, 7–8.5 mm. The ground color is dense black, the antennae and legs black. There is no pale ornamentation except in occasional specimens which have small, obscure, sutural spots at apical fourth. The proportions of the body are about as in *C. nobilis*, but the legs and basal antennal segments are much more robust. The face is much more deeply, broadly impressed in the frontal region, the humeri more prominent. Just behind the middle of the elytra there is a transverse raised line which takes the place of the yellow fascia in *nobilis*. The entire vestiture is very sparse in *lorquini* which is decidedly a distinct species.

Four specimens were examined from California (Yosemite, Riverton, Tenaya Gorge) and Nevada (Lake Tahoe). Type locality, California.

Genus **Tylcus** Casey

1912, Mem. on Col. III, 348–351

Chevrolat, 1860, Am. Soc. Ent. Fr. (3), 454. Thomson, 1860, Classif. Ceramb. 215. 1864, Syst. Ceramb., 423. Lacordaire, 1869, Gen. Col. IX, 63. Bates, 1880, Biol. C. Amer., V. 48. Leng, 1887, Ent. Amer., II, 194. Hopping, 1932, Ann. Ent. Soc. Amer., XXV, 533.

Type by original designation *Clytus hartwegi* White.

There is only a single species at present, but there are probably other forms from Mexico or Central America which belong here. The face is nearly perpendicular, and the emargination of the eyes only moderately deep. The antennal segments are elongate, some of them four times longer than broad. The hind legs are much longer than the middle pair, the first segment of the hind tarsus notably compressed. The elytra have subsutural carinae. The prosternal intercoxal piece is declivous, the mesosternal intercoxal piece definitely emarginate at the tip. The opening of the fore-coxal cavities is very narrow. The dorsal and ventral margins of the metepisternum are convergent from front to back.

Tylcus hartwegi (White)

(Plate III)

T. hartwegi (White) 1855, Nomenclature Col. Ins. in Brit. Mus. VIII, 252.

Length, 17 mm.; breadth, 4.5 mm. This species may be identified by the intricate elytral pattern (Plate III) and other characters as follows: The ground color is black, the base of the legs brown, the remainder black. The antennae are black basally to brown distally. The undersurface is uniformly covered with short, decumbent gray pubescence with longer, sparser, erect fine hairs; elytral ornamentation a mixture of cinereus and burnt orange. The pronotum is sparsely covered with short, decumbent, gray pubescence, without fasciae, and with a depression toward the margin on each side. The supra-antennal tubercles are prominent, the vertex between broadly, deeply impressed. Antennal segment 3 is longer than 4 and shorter than 5, the spine on 3 much larger than any of the other spines. The pencils of bristles basad of each spine and on 2 are well developed. The prosternum has a deep, transverse depression at the middle for the full width. The scutellum is triangular. The elytral apices are obliquely truncate—emarginate with the outer angle acutely spined, the spines slightly curved inwards.

One specimen was examined from Arizona. Type locality, Mexico (Oajaca). Type in the British Museum.

Genus **Sarosesthes** Thomson

1866, Systema Cerambycidarum, 185

Serville, 1834, Ann. Soc. Ent. Fr. III, 77. Leconte, 1850, Journ. Acad. Phila. (2) II, 16. Smith, 1873, Misc. Coll. XI (264, 319). Provancher, 1877, Faune Ent. Canada I, 596. Leconte and Horn, 1883, Classif. Col. N. Amer., 304. Leng, 1887, Ent. Amer. II, 197. Casey, 1912, Mem. on Col. III, 348.

Type by original designation *S. fulminans* (Fab.).

The single species *S. fulminans* (Fab.) was removed from *Arhopalus* Serville (1834) with apparent justification, because it disagrees with the generic description of *Arhopalus*. Serville says that the terminal segments of the palpae are triangular and they could hardly be called so in *fulminans*. This is not the first species listed by Serville under the generic description of *Arhopalus*.

The face is oblique, very flat, the terminal segment of the maxillary palpus five times longer than broad. The prosternal intercoxal piece

is almost flat, rounded at the tip and not appreciably expanded. The forepart of the mesosternum is feebly oblique, the intercoxal piece strongly sinuate emarginate at the tip. The antennae are filiform, a few of the distal segments with a trace of serration. Sub-sutural carinae are absent. The scutellum is broadly rounded behind. This genus seems to be intermediate between *Cyllene* and *Xylotrechus*.

Sarosesthes fulminans (Fabricius)

(Plate III)

S. fulminans (Fabricius), 1775, Syst. Ent., 192.

Length, 12–20 mm.; breadth, 3.5–6 mm. The ground color is black, the legs black, the antennae brown to black. The dorsal ornamentation is cinereus. The under-surface is dark brown to black anteriorly to brown on the abdomen, rather sparsely and uniformly covered with short gray pubescence. The pronotum has a shining carina extending from near the base to half way toward the apex. The apices of the elytra are narrowly truncate but unspined.

The species is easily recognized by the heart-shaped black spot on the pronotum with a smaller spot on each side and by the angulate, undulatory, narrow gray bands. Seventeen males and ten females were examined from Maryland, District of Columbia, Pennsylvania, Illinois, Missouri, Minnesota, and Kansas.

Genus **Ochraethes** Chevrolat

1860, Ann. Soc. Ent. Fr. (3) VIII, 454

Type designated by Thomson, 1864, *O. circuliferus* Chevrolat, Syst. Ceramb. 185. Mr. E. G. Linsley (1934, Trans. Amer. Ent. Soc. LXI, 86) has noted *Ochraethes sommeri* Chevrolat (=*O. circulifer* Chev.).
Ochroesthes Chevrolat, 1860, Ann. Soc. Ent. Fr. (3) VIII, 472.
Ochraesthes Thomson, 1860, Classif., Ceramb. 216.
Ochrestes Lacordaire, 1869, Gen. Col. IX, 65.
Ochresthes Bates, 1880, Biol. C.-Amer. V, 50.

The terminal segments of the palpae are equilaterally triangular or nearly so. The prosternal intercoxal piece is very narrow, declivous toward the tip, which is slightly expanded. The face is flat, the antennae filiform, tending toward serrate in some species, shorter than the body in the eleven species examined. The mesosternal intercoxal piece is feebly emarginate at the tip. In most species the abdominal intercoxal piece, although not acute at the tip, is proportionally narrower than in *Cyllene*.

Ochraethes sigmoideus Bates

(Plate III)

O. sigmoideus Bates, 1885, Biol. C. Amer. Col. V, 298, t. 21, f. 4.

Length, 14 mm.; breadth, 5 mm. The ground color is densely black but is largely obscured by dense yellow pubescence covering almost the entire body. The dorsal pubescence is brownish-yellow, the ventral

pubescence lemon-yellow. The legs are reddish-brown, quite densely yellow pubescent. The antennae are much shorter than the body, reddish-brown basally to almost black distally, gradually and slightly thickened toward the tips. The more robust form and antennae, and the markings, as shown in the figure, will serve to distinguish this species from closely allied forms such as *O. pollinosus* Chev. and *O. tulensis* Bates. It is also closely allied to *O. sommeri* Chev., but differs markedly in elytral pattern.

Three specimens were examined, two from Mexico and one from S. W. Texas. Base of Mt. Livermore, Davis Mts., 8,000–9,000 feet, Oct. 3, 1931 (E. R. Tinkham).

Subgenus **Triodoclytus** Casey

1912, Mem. on Col. III, 374.
1913, Mem. on Col. IV, 387.
Hopping, 1932, Ann. Ent. Soc. Am. XXV, 565.
Linsley, 1935, Trans. Am. Ent. Soc. LXI, 86.

Structurally, there is little difference between this and the genus *Ochraethes*, except in the rather strongly tapered antennae, and even this is not apparent in the females. *Ochraethes* is primarily a tropical genus and there is little doubt that *Triodoclytus lanifer* Lec. is a northern migrant of it. However, the typical undulant ornamentation is lacking as well as sub-sutural carinae. A discussion of this species with figure appears in Part I (Hopping, 1932, Ann. Ent. Soc. Am. XXV). Mr. E. G. Linsley has included *brevicornis* Chev. and *virescens* Chev. in *Triodoclytus* where they seem to belong. They also lack the undulant markings and sub-sutural carinae of most of the *Ochraethes*. It should be noted, however, that in the type species *O. sommeri*, the sub-sutural carinae are scarcely discernible.[4]

[4]General references are given in Part I (Hopping, 1932, Ann. Ent. Soc. Am., XXV) and are therefore not repeated here.

EXPLANATION OF PLATES

PLATE I

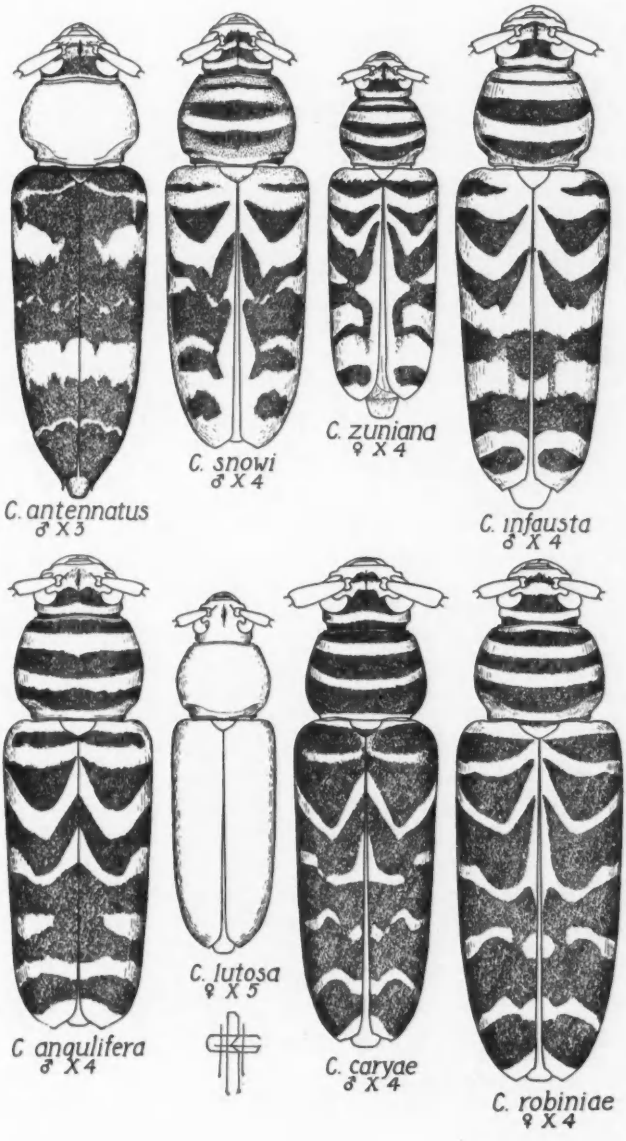
Species of Cyllene.

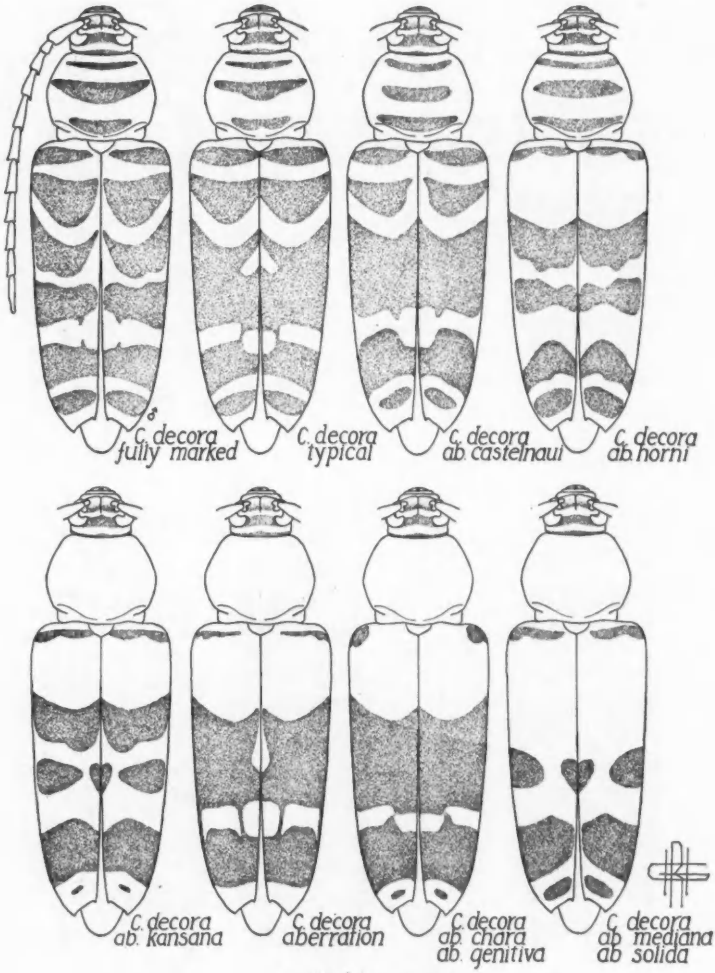
PLATE II

Cyllene decora Olivier and aberrations. N. B., Variations in pronotal bands are represented in upper figures. Bands omitted in lower figures.

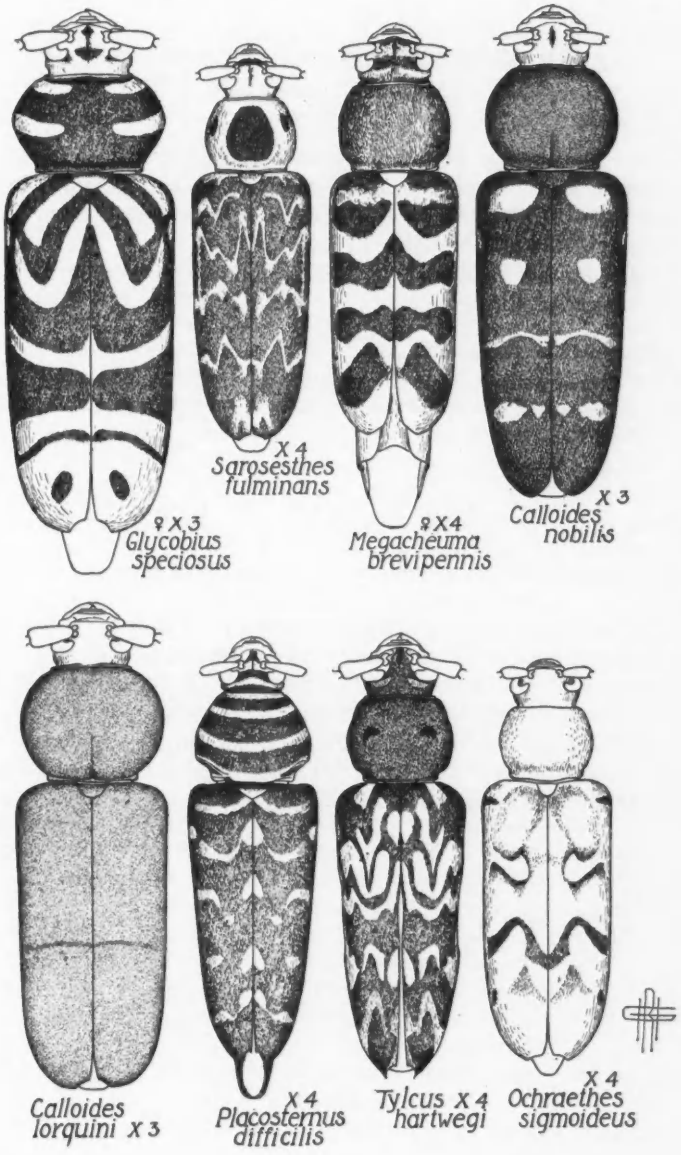
PLATE III

Species of Glycobius, Sarosesthes, Megacheuma, Calloides, Placosternus, Tyclus and Ochraethes.


C. antennatus
♂ X 3
C. snowi
♂ X 4
C. zuniana
♀ X 4
C. infausta
♂ X 4
C. angulifera
♂ X 4
C. lutosa
♀ X 5
C. caryae
♂ X 4
C. robiniae
♀ X 4



All figures X 3


♀ X 3
Glycobius speciosus
X 4
Saroseśthes fulminans
♀ X 4
Megacheuma brevipennis
X 3
Calloides nobilis
Calloides lorquini X 3
X 4
Placosternus difficilis
Tylcus X 4 hartwegi
X 4
Ochraethes sigmoideus

SEVENTH INTERNATIONAL CONGRESS FOR ENTOMOLOGY, BERLIN, 1938

By Resolution adopted by the Executive Committee for International Congresses for Entomology, the *Seventh International Congress for Entomology* will convene in Berlin, from August 15th to 20th, 1938.

Discussions will be held in the following sections and on the subjects indicated below:

A. General Entomology:

(1) Systematism and Zoogeography. (2) Nomenclature and Bibliography. (3) Morphology, Physiology, Embryology and Genetics. (4) Oecology.

B. Applied Entomology:

(1) Medical and Veterinary-Medical Entomology. (2) Agriculture and Sericulture. (3) Forest Entomology. (4) Agricultural Entomology; (a) Viticulture and pomiculture. (b) Agriculture and olericulture. (c) Pests. (5) Means and methods for fighting pests.

The Management of the Congress would deeply appreciate the participation of numerous Representatives in the Pure Science and in the Applied Science of Entomology in the Congress to be convened in Berlin.

All entries for participation, and all inquiries, should be addressed to the Secretary General, Professor Dr. Hering, Invalidenstrasse 43, Berlin N. 4.

TERMITE PHYLOGENY AS EVIDENCED BY SOLDIER MANDIBLE DEVELOPMENT

LAURA HARE,
87 West 43rd St.,
Indianapolis, Indiana

An understanding of the phylogeny of any group is attained only after an exhaustive investigation has been made of all possible contributing evidence. Hence this study was undertaken more with a view to ascertain how closely the systematics, based solely upon the development and differentiation of soldier termite mandibles, would corroborate the more or less accepted phylogeny. Although it has been subsequently modified in a number of respects, Holmgren's (1911–1912) classification of the Isoptera is accepted in its major portion. Therefore the conclusions which I drew from a mandibular study will be briefly compared with the above mentioned work.

It is well known that within the soldier caste wide degrees of mandibular specialization are manifested, ranging from the greatly elongated snapping type of the genus *Termes* (= *Mirotermes*) and the asymmetrical form of *Capritermes* to the degenerate vestiges of certain of the *Nasutitermes*. Using the degree and type of digression of the mandible of the soldier from that of the imago or worker-type as a fundamental basis for judgment, the relationship among groups was tentatively worked out.

I had an opportunity to collect and study a considerable portion of the material for this problem during a six months stay from April 5 until September 14, 1935, at Barro Colorado Island Biological Laboratory in the Panama Canal and I should like at this time to thank Mr. James Zetek, whose co-operation in innumerable ways made this an ideal place in which to work. For the remainder of the specimens I wish to express deep gratitude to Dr. A. E. Emerson, from whose entire collection I was permitted to select representative series; to Dr. L. R. Cleveland, for specimens of *Cryptocercus punctulatus;* to Dr. G. F. Hill, for specimens of *Porotermes;* and to Dr. S. F. Light, for *Zootermopsis* material. Also I am greatly indebted to Dr. Emerson for many suggestions and for the time he has spent in going over the material with me.

The mandibles were dissected out in alcohol, cleared in xylol, and mounted in balsam so that they could be measured

with an ocular micrometer (Table I) and camera lucida drawings made of them. To facilitate comparison the designation of teeth will follow Emerson (1933), who recognized an apical tooth, marginal teeth, and a basal molar striated plate, the pars molaris of Imms (1919). Snodgrass (1935), in describing an orthopteroid mandible, refers to the distal toothed incisor lobe and the proximal molar lobe of the mesal surface. The ginglymus is a dorsal articular projection acting as a hinge for the mandibular attachment to the clypeus of the head capsule and ventrally the condyle fits into a cup-like cavity on the anterior border of the floor of the head (Imms, 1919).

PHYLOGENETIC STUDY

In the determination of the interrelationship of the forms studied, the mandibles of the soldier nymphs of the penultimate instar proved of great value. Their significance in this transitional stage during which the outline of the developing mature mandible is discernible within, was previously suggested (Hare 1934). Mannville (1935) traced the development in the alate and soldier of *Zootermopsis angusticollis* (Hagen) and compared the mandibles of nymph, penultimate soldier nymph termed by him "pseudosoldier," and mature soldier with each other and with the corresponding ones of *Coptotermes vastator* (Light), *Termes* (=Odontotermes) *dives* Hagen, *Amitermes wheeleri* (Desneux), *Macrotermes gilvus* (Hagen), and *Hospitalitermes luzonensis* (Oshima), including also the cockroach *Periplaneta australasiae* (Fabricius).

After a preliminary survey of all the material available which includes fifty-three species of thirty-two representative genera of the four families, the conclusion was drawn that the greater divergence and specialization of the soldier from the imago or worker-type mandibles accompanied the development of the more recently evolved termites from the primitive groups. It may be seen from Plate VI that in *Hodotermes* and the *Kalotermitidae* lowest in the phylogenetic scale, *Stolotermes*, *Zootermopsis*, and *Porotermes*, the mandibular teeth of the imago-type, the late soldier nymph, and the mature soldier can be easily homologized, but as we ascend the hypothetical phylogenetic tree this similarity no longer endures. In the subfamily *Kalotermitinae* the soldier displays an additional marginal tooth in the left mandible, probably the result of a division of the first marginal tooth of the imago-type. Digression becomes more pronounced in the *Rhinotermitidae;* here *Rhinotermes* (*R.*) forms a striking example of the loss of marginal teeth, particularly in the minor soldier (Fig. 20). Finally, within the *Termitidae* one finds the greatest extremes of specialization from formidable defensive weapons of *Cornitermes*, *Armitermes*, and the *Termitinae*, to the nearly functionless degenerate structures of certain of the *Nasutitermes* species (Plates X–XII).

Plate I represents the phylogenetic relationship of the species studied as tentatively arrived at by a consideration of mandibular develop-

ment and Plate II represents the conclusions set forth by Holmgren (1911–1912). Discrepancies manifested in these two schemes will be pointed out and brief mention made of other versions deducted from various data. I am aware of the inadequacy of this type of diagram but feel that it is justifiable where the necessity arises to present a broad concept of interrelationships in condensed form.

Since termites have arisen from a Blattid stock, I have included the mandibles of one of their closest living relatives, namely the wood-eating roach *Cryptocercus punctulatus*, and of *Periplaneta americana* (Figs. 1 and 2). *Mastotermes darwiniensis* (Fig. 3) is universally conceded to be the most primitive termite existing today, and Browman's (1935) study of the chitinous genitalia of female termites reiterates this verdict.

The small *Hodotermes* group is accepted now as a separate family and judging from its affinities it would seem to have sprung from the *Kalotermitidae* stock. The left imago-type mandibles of *Hodotermes* and *Zootermopsis* (Figs. 4 and 6) show no great dissimilarity, but the absence in the right mandible of *Hodotermes* of the small sub-apical tooth approaches the condition of the roaches more closely than does *Zootermopsis*. My placement of *Porotermes* closer to *Zootermopsis* than to the *Kalotermitinae* was determined because of the similarity displayed by the imago-type mandibles to those of *Zootermopsis* and the close agreement of the soldier, particularly the soldier nymph, to *Stolotermes* (Plate VI). From his data, Browman (1935) suggests "a possible branching off of *Porotermes* from the *Kalotermes* stem early in its history." The arrangement of the *Kalotermitinae*, of which *Kalotermes s. str.* is the basic stock (Plate VII), indicates no gross dissimilarity in the two diagrams. The entire group is characterized by the loss of the third marginal tooth or the fusion of the second and third in the left imago-type mandible. The supposition that *Cryptotermes*, with its shallow teeth in the mature soldier, has evolved in one direction while *Calcaritermes* and *Glyptotermes* have followed a different course is borne out by a corresponding diversity in wing venation.

Among the species of *Rhinotermitidae* (=Holmgren's *Mesotermitidae*) available for comparison, the imago or worker-type mandibles are very much alike. In place of the reduced number of marginal teeth in the left mandible, as described for the *Kalotermitinae*, the full quota of three is present which would indicate a relationship with the early Kalotermitid stock, particularly *Stolotermes*. A small sub-apical tooth in the right mandible is present in all the forms studied which further bears out the probable derivation of the *Rhinotermitidae* from a primitive stock related to *Stolotermes* and the *Termospinae*. With the exception of the *Rhinotermitinae* the penultimate soldier nymph mandibles likewise show a similarity in general shape and in the arrangement of teeth (Plate VIII). *Rhinotermes R. longilabius* (Fig. 20) appears to have undergone extreme specialization, particularly in the minor soldier where all marginal teeth have disappeared.

The family *Termitidae* (=Holmgren's *Metatermitidae*) would seem to have evolved from the *Rhinotermitidae*. In the fungus-growing subfamily *Macrotermitinae* (=Holmgren's *Termes* Reihe) one notes a per-

ceptible decrease in the size of the second marginal tooth of the left imago-type mandibles (Plate IX). In the right mandibles the loss of the small sub-apical tooth, present in all *Rhinotermitidae*, is at once apparent, although *Acanthotermes* (Fig. 22) displays a shallow vestige of this structure. My arrangement of *Protermes* and *Odontotermes* would indicate a closer relationship between these two than is designated by Holmgren (Plate III, A and B). The imago-type mandibles of these two bear a strong resemblance; the third marginal tooth of the left mandibles is less deeply cut than in *Microtermes*, *Sphaerotermes*, and *Acanthotermes*, specialization in this direction reaching its climax in the more nearly smooth condition of *Macrotermes*.

The subfamily *Nasutitermitinae* (=Holmgren's *Syntermes* Reihe) (Plates X and XI) presents a remarkable picture of specialization, mandibular degeneration in the soldier being accompanied by development of the frontal gland and nasus. This is depicted by the series beginning with *Syntermes* and ending with the highly modified *Nasutitermes* subgenera (Plates X and XI). Owing to its wide representation on Barro Colorado Island I was able to obtain abundant material for the study of the genus *Nasutitermes*, within which group may be traced a process of specialization involving almost complete degeneration of the soldier mandibles as in *Subulitermes*, *Convexitermes*, and *Trinervitermes* (Figs. 33, 34 and 43). My arrangement of these subgenera in evolutionary sequence agrees with that of Holmgren (Plate IV, A and B) in most respects, excepting my placement of *Trinervitermes* and *Ceylonitermes* as illustrative of extreme specialization whereas Holmgren places these two subgenera nearer the center of his scheme. *Subulitermes* and *Convexitermes*, also highly modified, I believe to have evolved in a slightly different direction as the left worker-type mandibles have the small second marginal tooth as in *Armitermes* (*A.*) and the right ones have the first and second marginal teeth so allied that they appear to have a common base; this latter peculiarity is likewise suggested in *Armitermes* (*A.*) and in *Angularitermes* (Figs. 30 and 32–34). The last named subgenus, *Angularitermes*, had not been described when Holmgren published his classification. I have assigned to it the basic position given by him to *Nasutitermes s. str.*

The soldiers of the subfamily *Termitinae* (=Holmgren's *Miro-Capritermes* Reihe) display a mandibular evolution morphologically toward asymmetry and functionally from a biting to a snapping ability. Emerson (manuscript) experimented with soldiers of *Termes panamensis* among others to determine their reaction when attacked by the "crazy" ants, *Paratrechina longicornis* Lat., and found that the propelling force of the snapped mandibles is utilized effectively as a defense mechanism. In the arrangement of the genera of this subfamily the possible interrelationships were weighed by a consideration of both the structure of imago-type and soldier mandibles and the function of the latter. All the genera examined except *Capritermes* and *Neocapritermes* show a wide separation of the apical and first marginal teeth in the imago-type mandibles, a pronounced specialization (Plate XII). *Orthognatholermes* (Fig. 47), its soldier mandibles used both for biting and for snapping, appears to be a transitional form between *Cubitermes*, capable only of

biting, and *Termes* which has evolved toward a predominantly snapping mechanism. The soldiers of *Capritermes* and *Neocapritermes* (Figs. 49 and 50) also have snapping mandibles, specialized to a condition of asymmetry, but the more primitive condition of the imago-type mandibles points to an early separation from the *Termes* and *Cavitermes* group. It must then be assumed that the snapping mandibles have evolved at least twice in this subfamily. The retention of marginal teeth in the greatly elongated soldier nymph mandibles (Figs. 44–48) is an interesting example of recapitulative force acting upon a nonfunctional structure.

I disagree with the position assigned by Holmgren to *Microcerotermes* (Plate II); this genus definitely belongs to the *Termitidae* (=Holmgren's *Metatermitidae*) and should not therefore, in my opinion, be derived apart from the rest of that family. The imago or worker-type mandibles also prohibit the suggested relation to the *Rhinotermitidae;* the teeth of the left mandible resemble those of *Amitermes*, the second marginal tooth being reduced to a mere vestige, and in the right mandible the small tooth at the base of the first marginal tooth, so typical of all *Rhinotermitidae*, is lacking in *Microcerotermes* (Fig. 55). The soldier mandibles are sufficiently similar to *Cylindrotermes* to conceive of their being a further specialization along that line of development (Figs. 52 and 55). Because of the evidence presented above I have placed *Microcerotermes* close to the *Amitermitinae* (=Holmgren's *Hamitermes* Reihe) (Plate I).

The phylogenetic affinities of *Anoplotermes* (Figs. 53 and 54) are puzzling; Holmgren (1912) placed this genus with *Nasutitermes* (Plate IV, B) but I cannot substantiate such a decision. Light (1933) draws attention, from a comparison of the imago-type mandibles, to a resemblance between *Hoplotermes*, a genus of *Amitermitinae*, and *Anoplotermes*. This similarity appears quite striking as is also the case with *Eurytermes*, the latter a genus closely related to *Hoplotermes*. Because of these facts I have placed *Anoplotermes* with the *Amitermitinae* (Plate I).

DISCUSSION

The study of the mandibles of termites, primarily to determine what evidence they contribute to the problem of phylogeny, has suggested that an understanding of their development may have a bearing upon certain general concepts.

The soldier termite, a caste morphologically and functionally distinct from other colony members, constitutes one of the best examples among the social insects of polymorphic development. The origin of polymorphism in the phylogeny of termites was probably bound up, according to Wheeler (1928), with the production of neoteinic individuals within the family, the loss of fertility among them, and the evolution simultaneously of behavioristic and structural differences enabling a division of labor. The potentialities for these changes would necessarily have been initiated in the hereditary mechanism of the primitive winged form. According to recent experiments with *Zootermopsis angusticollis* (Hagen) the ontogenetic production of at least some termite

castes is dependent upon chemical factors. Results obtained by Castle (1934) in experimental colonies have produced interesting evidence substantiating this claim.

The origin and subsequent diversification of the soldier involves, among others, questions of neoteny, adaptation, inheritance, and evolution. Evidence suggests that the soldier arose from the first form reproductives by arrested development and specialization (Emerson (1926.) They may therefore in a sense be termed neoteinics as are the complemental second and third form reproductives. In order to explain the morphological differences in the mandibles it must be conceded that slight variations and mutations have occurred and, weighing the relative degree of protection afforded by these modified soldiers, natural selection may have acted upon the colony as a whole over a long period of time (Darwin 1859). Certainly Lamarckian evolution is ruled out as a tentative explanation. Even Darwin states, in "The Origin of Species": "I am surprised that no one has hitherto advanced this demonstrative case of neuter insects, against the well known doctrine of inherited habit, as advanced by Lamarck." Because of their sterility any theory based upon the direct inheritance of a functionally acquired character in the soldier caste must be discarded.

There arises the question of the rôle played by adaptation in determining the course of evolution. The general trend toward development of enlarged mandibles, more elongated and pointed than the imagotype, together with the defensive behavior pattern of the soldier termite is certainly an adaptive feature. The value of this mechanism in defense is demonstrated by Emerson (manuscript) in experiments with the "crazy ant" *Paratrachina longicornis* Lat., during the course of which the soldiers proved much more capable of defending themselves than did the termite workers. Morphological variations in mandibles form no exception, however, to the general rule that species or even generic differences rarely have adaptive significance.

On the other hand local races may arise within a group and may have fixed in them nonadaptive character complexes due to a tendency in the course of evolution for gene frequencies to drift about (Wright 1932). This is possible because of the fact that one gene affects many characters and the phase of the gene which is best for one organ may be injurious to or have random effect upon another, thus resulting in nonadaptive evolution of the latter. Once established, such a sub-group may survive providing it escapes the selection factor which, after all, acts upon the whole rather than on specific parts. This may be the explanation for the almost total degeneration of the soldier mandibles in the subfamily *Nasutitermitinae* and in certain species of *Rhinotermes*. Darlington (1935), in his search for an explanation for the atrophy of the wings in certain Carabid beetle families finds neither the theory of natural selection nor of Lamarckian inheritance to be adequate; he favors the view of recurrent mutations as a most satisfactory explanation and one which requires no supplementary evolutionary action. One may question, however, whether any one factor alone should be advanced as adequate within itself.

With special regard to ontogenetic development the failure of certain mandibular teeth to manifest themselves in the adult soldier is in many cases anticipated in the penultimate instar of the nymph. Traces of these teeth, presumably homologous with those of the imago-type, remain, however, until the final molt. These vestiges can be of no possible adaptive value since they are insufficiently chitnizied for chewing or for defensive purposes and their presence therefore seems to be purely recapitulative but a necessary step in the formation of the mandible which is to follow. Needham (1930) expresses a more recent version of the old recapitulation theory in his statement: "It looks as if organs are only recapitulated in so far as they are necessary for the development of the ones which are required in the ontogeny in question, and all the other old ones disappear."

The penultimate stadium of the soldier termite is a rather unique developmental stage. It differs from the corresponding period in the ontogeny of other paurometabolous insects in the fact that, although the individual increases in size before the final molt and therefore must receive food as do other nymphs, the condition of its mandibles renders it entirely dependent upon the care of other colony members. At this time it might fairly be considered a liability rather than an asset to the group, for not until its mature form is assumed can it function in a defensive rôle. The possibility that there may be two such nymphal stages during which the mandibles are definably those of the soldier caste in *Armitermes* (*Rhynchotermes*) *perarmatus* was suggested during my collection of this species from an extensive nest containing many immature individuals. Although the younger of these soldier nymphs occurred in much fewer numbers than the more advanced ones, about one to ten, at least a dozen of the former were studied (Fig. 31) and no individuals were observed which displayed the mandibles or nasus in an intermediate stage of development; the two groups appeared to be distinct. If this supposition is accepted it provides the only case among all the species examined in which the mature soldier is evolved by three molts rather than by two from the imago or worker-type nymph.

There is a possibility that the process of mandibular differentiation may have a physiological background involving genetic control of thresholds comparable to the situation occurring in *Drosophila* as described by Goldschmidt (1935). Working with the allelomorphic series of genes affecting wing development ranging from normal to vestigial, Goldschmidt found a correlation between the degree of divergence from normal-type wing and the threshold in development at which the defect is initiated: "das Mass der Beschneidung des Flügels ist eine Funktion der früheren oder späteren Erkrankung des Flügelepithels," thus deformation resulting in vestigial-type wings is definable at a much earlier stage in development than the modification which appears in the adult as vestigial-notched. The question arises, is this general concept applicable in a broad sense to the situation among termites? If the mandibles of the soldiers of all genera could be followed throughout their development would the time at which differentiation is initiated correspond relatively to the degree of divergence finally produced?

CONCLUSIONS

The evidence obtained from the study of mandibular development and differentiation among the soldier termites indicates that this structure corroborates quite consistently the scheme of phylogeny as based upon other criteria. It is, in fact, surprising how accurately the phylogenetic position of the various genera is paralleled by a corresponding manifestation of specialization of the soldier mandibles whether in the direction of elaboration or degeneration.

The hypothetical trees have been used as an aid in designating the probable trend of evolution within the Isoptera. Wright (1932) has shown that the evolutionary process depends upon the interrelationship of a number of factors including fortuitous gene mutations and chromosomal aberrations, local inbreeding and crossbreeding, local and intergroup selection, migration and isolation. Although we may be prone to associate increased adaptive propensities with this evolution, due to the fact that a single gene may affect many characters and vice versa it often occurs that degeneration of certain characters (usually compensated for by greater specialization elsewhere), may likewise be tolerated. The comparatively useless mandibles of the nasute soldiers might be cited as such an example. As a general rule, however, among termites the soldier mandibles are adaptively modified and we assume that the presence of this caste may have been initiated phylogenetically by the potentialities of the first form reproductives to produce offspring with slight variations or mutations which over a long period proved beneficial to the colony as a whole.

The penultimate instar of the soldier nymph proves to be an interesting transitional form with mandibles retaining a semblance of the imago or worker-type form yet anticipating that of the divergent mature soldier.

TABLE I

Relative Size of Mandibles in Millimeters

(a) Measurement from outer edge of condyle to tip of apical tooth.
(b) Width at approximately the broadest point distal to the base.

Species		Imago or Worker-Type		Soldier Nymph Penultimate Instar		Mature Soldier	
		Left	Right	Left	Right	Left	Right
Cryptocercus punctulatus Scudder.	a.	1.617	1.588				
	b.	.882	1.000				
Periplaneta americana Linnaeus.	a.	1.135	1.118				
	b.	.647	.647				
Mastotermes darwiniensis Froggatt.	a.	.823	.735	..	..	2.294	2.205
	b.	.647	.765			.970	1.000
Hodotermes (*Anacanthotermes*) *ochraceus* (Burm.)	a.	1.382	1.294	2.118	1.970	2.647	2.499
	b.	1.059	1.235	1.047	1.059	1.118	1.294
Stolotermes ruficeps Braver.	a.	.493	.459	1.147	1.059	1.447	1.335
	b.	.382	.412	.564	.499	.499	.540
Zootermopsis nevadensis (Hagen).	a.	.988	.905	3.088	3.000	3.588	3.470
	b.	.735	.882	1.205	1.235	1.323	1.176
Porotermes Adamsoni Froggatt.	a.	.735	.700	1.364	1.353	1.765	1.647
	b.	.558	.647	.823	.823	.794	.852
Kalotermes (*Calcaritermes*) *brevicollis* Banks.	a.	.382	.353	.529	.499	.617	.605
	b.	.294	.294	.323	.353	.323	.323
Kalotermes (*K.*) *tabogae* Snyder.	a.	.588	.529	1.294	1.235	1.540	1.499
	b.	.470	.470	.647	.676	.617	.588
Kalotermes (*Cryptotermes*) *dudleyi* Banks.	a.	.423	.359	.676	.617	.976	.941
	b.	.323	.353	.441	.456	.397	.400
Kalotermes (*Glyptotermes*) *angustus* Snyder.	a.	.305	.235	.617	.617	.706	.676
	b.	.264	.279	.382	.353	.353	.370
Kalotermes (*Proneotermes*) *peresi* Holmgren.	a.	.558	.493	1.335	1.264	1.676	1.573
	b.	.435	.453	.623	.676	.676	.647
Kalotermes (*Rugitermes*) *panamae* Snyder.	a.	.540	.499	1.341	1.264	1.882	1.823
	b.	.470	.470	.735	.823	.765	.765
Kalotermes (*Neotermes*) *contracticornis* Snyder.	a.	.588	.499	1.205	1.147	1.676	1.588
	b.	.470	.529	.647	.676	.706	.676
Psammotermes allocerus Sylvestri.	a.	.588	.564	1.323	1.364	1.599	1.647
	b.	.441	.505	.647	.647	.617	.706
Coptotermes ceylonicus Holmgren.	a.	.529	.470	.929	.911	.976	.976
	b.	.412	.470	.441	.412	.294	.294
Heterotermes tenuis Hagen.	a.	.382	.353	1.088	1.059	1.264	1.264
	b.	.323	.323	.353	.370	.353	.353
Reticulitermes arenincola Goellner.	a.	.441	.429	.911	.870	1.011	.988
	b.	.353	.382	.353	.441	.376	.382
Prorhinotermes simplex Hagen.	a.	.558	.499	1.165	1.153	1.264	1.264
	b.	.429	.499	.470	.470	.441	.429
Rhinotermes (*Schedorhinotermes*) *lamanianus* Sjostedt.	a.	.588	.499			Minor	
	b.	.470	.588			.753	.753
						.282	.276
						Major	
	a.					1.100	1.029
	b.					.470	.481

TABLE I—(*Continued*)

Species		Imago or Worker-Type		Soldier Nymph Penultimate Instar		Mature Soldier	
		Left	Right	Left	Right	Left	Right
Rhinotermes (*R.*) *longilabius* Emerson.	a.	.476	.412	Minor .294	.294	Minor .323	.323
	b.	.353	.441	.165	.165	.118	.118
	a.			Major .676	.617	Major .823	.788
	b.			.412	.382	.294	.294
Amitermes (*A.*) *medius* Banks.	a.	.558	.529	.882	.823	1.118	1.059
	b.	.382	.412	.487	.470	.412	.394
Cylindrotermes macrognathus Snyder.	a.	.373	.323	.800	.806	1.000	1.000
	b.	.279	.323	.412	.412	.353	.353
Anoplotermes (*A.*) *gracilis* Snyder.	a.	.400	.394				
	b.	.235	.270				
Anoplotermes (*Speculitermes*) *arboreus* Emerson.	a.	.588	.546				
	b.	.335	.412				
Microcerotermes arboreus Emerson.	a.	.441	.376	1.044	1.000	1.135	1.129
	b.	.311	.323	.364	.412	.353	.364
Snytermes snyderi Emerson.	a.	1.540	1.453	3.588	3.335	4.118	3.823
	b.	.976	1.147	1.794	1.765	1.794	2.118
Cornitermes (*C.*) *acignathus* Snyder.	a.	.837	.794	1.412	1.397	1.661	1.647
	b.	.499	.529	.794	.882	.647	.676
Armitermes (*Rhynchotermes*) *perarmatus* Snyder.	a.	.706	.676	Antipen .629	ultimat .599	e? .970	.970
	b.	.429	.529	.323	.335	.235	.205
	a.			Penulti .647	mate .676		
	b.			.388	.376		
Armitermes (*A.*) *chagresi* Snyder.	a.	.529	.505	.970	.958	1.235	1.235
	b.	.311	.382	.529	.546	.441	.412
Nasutitermes (*Subulitermes*) *kirbyi* Snyder.	a.	.364	.335	.147	.118	.147	.147
	b.	.187	.246	.118	.147	.106	.088
Nasutitermes (*Convexitermes*) *clevelandi* Snyder.	a.	.353	.329	.118	.112	.124	.147
	b.	.205	.258	.118	.124	.082	.070
Nasutitermes (*Angularitermes*) *nasutissimus* Emerson.	a.	.682	.647	.353	.294	.294	.176
	b.	.400	.470	.252	.353	.294	.353
Nasutitermes (*N.*) *columbicus* Holmgren.	a.	.529	.499	.176	.176	.176	.176
	b.	.412	.470	.187	.211	.124	.135
Nasutitermes (*N.*) *pilifrons* Holmgren.	a.	.435	.376	.294	.246	.205	.176
	b.	.323	.353	.223	.235	.176	.176
Nasutitermes (*N.*) *ephratae* Holmgren.	a.	.412	.382	.205	.205	.176	.129
	b.	.294	.353	.176	.199	.147	.153
Nasutitermes (*N.*) *corniger* Motsch.	a.	.470	.453	.176	.147	.118	.118
	b.	.353	.412	.176	.182	.147	.147
Nasutitermes (*Constrictotermes*) *cavifrons* Holmgren.	a.	.582	.540	.235	.294	.235	.264
	b.	.341	.470	.235	.235	.264	.223
Nasutitermes (*Uniformitermes*) *barrocoloradensis* Snyder.	a.	.535	.529	Minor .147	.147	Minor .106	.118
	b.	.311	.412	.124	.124	.118	.118
	a.			Major .205		Major .147	.141
	b.			.147		.129	.135

TABLE I—(Continued)

Species		Imago or Worker-Type		Soldier Nymph Penultimate Instar		Mature Soldier	
		Left	Right	Left	Right	Left	Right
Nasutitermes (*Velocitermes*) *beebei* Emerson.	a.	.558	.529	Minor .205	.187	Minor .147	.147
	b.	.376	.470	.147	.147	.118	.118
	a.			Major .294	.276	Major .235	.223
	b.			.235	.235	.176	.199
Nasutitermes (*Ceylonitermes*) *escherichi* Holmgren.	a.	.529	.529	.147	.176	.118	.118
	b.	.376	.441	.141	.153	.106	.118
Nasutitermes (*Trinervitermes*) *bettonianus* (Sjostedt).	a.	.729	.676			Minor .217	.223
	b.	.599	.605			.118	.141
	a.			Major .205	.205	Major .294	.294
	b.			.235	.235	.176	.176
Procubitermes niapuensis Emerson.	a.	.582	.546	1.529	1.529	1.658	1.635
	b.	.294	.382	.470	.412	.412	.353
Cubitermes fungifaber Sjostedt.	a.	.735	.706	1.882	1.882	2.353	2.329
	b.	.423	.470	.605	.676	.706	.706
Orthognathotermes wheeleri Snyder.	a.	.647	.588	2.059	1.941	2.499	2.441
	b.	.400	.441	.470	.529	.706	.664
Termes panamensis Snyder.	a.	.412	.394	1.676	1.647	1.823	1.823
	b.	.252	.294	.412	.382	.412	.294
Cavitermes tuberosus Emerson.	a.	.487	.459	1.852	1.765	2.059	1.970
	b.	.294	.323	.517	.412	.499	.412
Capritermes (*Neocapritermes*) *angusticeps* Emerson.	a.	.776	.647	2.794	2.706	3.176	3.000
	b.	.441	.558	.647	.617	.823	.735
Capritermes (*C.*) *minor* Holmgren.	a.	.564	.529	1.353	1.294	1.505	1.529
	b.	.323	.412	.499	.382	.470	.423
Acantholermes (*Pseudoacanthotermes spiniger* (Sjostedt).	a.	.765	.747	.911	Minor .882	1.000	Minor 1.059
	b.	.453	.647	.353	.353	.294	.323
	a.			1.323	Major 1.246	1.470	Major 1.412
	b.			.529	.558	.558	.617
Sphaerotermes sphaerothorax (Sjostedt).	a.	.441	.412	.558	.588	.647	.635
	b.	.276	.353	.294	.388	.264	.270
Microtermes pallidus Haviland.	a.	.588	.558	.688	.647	.776	.765
	b.	.382	.441	.329	.353	.235	.323
Odontotermes (*O.*) *kabarensis* Fuller.	a.	.941	.882	1.353	1.305	1.664	1.629
	b.	.647	.765	.623	.664	.676	.706
Protermes (*P.*) *hirticeps* Sjostedt.	a.	.670	.629	.635	.617	.647	.617
	b.	.447	.576	.329	.341	.270	.323
Macrotermes natalensis (Haviland).	a.	.941	.882	1.765	Minor 1.753	2.059	Minor 2.118
	b.	.576	.735	.664	.664	.599	.647
	a.			2.353	Major 2.353	2.882	Major 2.882
	b.			1.023	1.011	.970	1.118

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EXPLANATION OF PLATES

PLATE I

Hypothetical phylogenetic tree as deduced from mandibular data.

PLATE II

Hypothetical phylogenetic tree after Holmgren.

PLATE III

Subfamily *Macrotermitinae*. A. From mandibular data. B. After Holmgren.

PLATE IV

Genus *Nasutitermes*. A. From mandibular data. B. After Holmgren.

PLATE V

Subfamily *Termitinae*. A. From mandibular data. B. After Holmgren.

PLATE VI

Mandibles of:

Fig. 1. *Cryptocercus punctulatus* Scudder, nymph.
Fig. 2. *Periplaneta americana* (Linnaeus), nymph.
Fig. 3. *Mastotermes darwiniensis* Froggatt. a. Imago or worker-type. b. Soldier.
Fig. 4. *Hodotermes* (*Anacanthotermes*) *ochraceus* (Burm.). a. Imago or worker-type. b. Penultimate soldier. c. Soldier.
Fig. 5. *Stolotermes ruficeps* Braver. a. Imago-type. b. Penultimate soldier. c. Soldier.
Fig. 6. *Zootermopsis nevadensis* (Hagen). a. Imago-type. b. Penultimate soldier. c. Soldier.
Fig. 7. *Porotermes adamsoni* (Froggatt). a. Imago-type. b. Penultimate soldier. c. Soldier.

PLATE VII

Mandibles of:

Fig. 8. *Kalotermes* (*Calcaritermes*) *brevicollis* Banks. a. Imago-type. b. Penultimate soldier. c. Soldier.
Fig. 9. *Kalotermes* (*Glyptotermes*) *angustus* Snyder. a. Imago-type. b. Penultimate soldier. c. Soldier.
Fig. 10. *Kalotermes* (*Rugitermes*) *panamae* Snyder. A. Imago-type. b. Penultimate soldier. c. Soldier.
Fig. 11. *Kalotermes* (*Kalotermes*) *tabogae* Snyder. a. Imago-type. b. Penultimate soldier. c. Soldier.
Fig. 12. *Kalotermes* (*Kalotermes*) *perezi* Holmgren. a. Imago-type. b. Penultimate soldier. c. Soldier.
Fig. 13. *Kalotermes* (*Neotermes*) *contracticornis* Snyder. a. Imago-type. b. Penultimate soldier. c. Soldier.
Fig. 14. *Kalotermes* (*Cryptotermes*) *dudleyi* Banks. a. Imago-type. b. Penultimate soldier. c. Soldier.

PLATE VIII

Mandibles of:

Fig. 15. *Coptotermes ceylonicus* Holmgren. a. Imago or worker-type. b. Penultimate soldier. c. Soldier.

Fig. 16. *Reticulitermes arenincola* Goellner. a. Imago or worker-type. b. Penultimate soldier. c. Soldier.

Fig. 17. *Heterotermes tenuis* Hagen. a. Imago or worker-type. b. Penultimate soldier. c. Soldier.

Fig. 18. *Psammotermes allocerus* Silvestri. a. Imago or worker-type. b. Penultimate soldier. c. Soldier.

Fig. 19. *Prorhinotermes simplex* Hagen. a. Imago or worker-type. b. Penultimate soldier. c. Soldier.

Fig. 20. *Rhinotermes* (*Rhinotermes*) *longilabius* Emerson. a. Imago or worker-type. b. Penultimate minor soldier. c. Minor soldier. d. Penultimate major soldier. e. Major soldier.

Fig. 21. *Rhinotermes* (*Schedorhinotermes*) *lamanianus* (Sjöstedt). a. Imago or worker-type. b. Minor soldier. c. Major soldier.

PLATE IX

Mandibles of:

Fig. 22. *Acanthotermes* (*Acanthotermes*) *acanthothorax* (Sjöstedt). a. Imago or worker-type. b. Penultimate minor soldier. c. Minor soldier. d. Penultimate major soldier. e. Major soldier.

Fig. 23. *Sphaerotermes sphaerothorax* (Sjöstedt). a. Imago or worker-type. b. Penultimate soldier. c. Soldier.

Fig. 24. *Microtermes pallidus* Haviland. a. Imago or worker-type. b. Penultimate soldier. c. Soldier.

Fig. 25. *Odontoterme* (*Odontotermes*) *kabarensis* Fuller. a. Imago or worker-type. b. Penultimate soldier. c. Soldier.

Fig. 26. *Protermes* (*Protermes*) *hirticeps* Sjöstedt. a. Imago or worker-type. b. Penultimate soldier. c. Soldier.

Fig. 27. *Macrotermes* (*Bellicositermes*) *natalensis* (Haviland). a. Imago or worker-type. b. Penultimate minor soldier. c. Minor soldier. d. Penultimate major soldier. e. Major soldier.

PLATE X

Mandibles of:

Fig. 28. *Syntermes snyderi* Emerson. a. Imago or worker-type. b. Penultimate soldier. c. Soldier.

Fig. 29. *Cornitermes* (*Cornitermes*) *acignathus* Snyder. a. Imago or worker-type. b. Penultimate soldier. c. Soldier.

Fig. 30. *Armitermes* (*Armitermes*) *chagresi* Snyder. a. Imago or worker-type. b. Penultimate soldier. c. Soldier.

Fig. 31. *Armitermes* (*Rhynchotermes*) *perarmatus* Snyder. a. Imago or worker-type. b. Head of pre-penultimate (?) soldier. c. Pre-penultimate (?) soldier. d. Head of penultimate soldier. e. Penultimate soldier. f. Soldier.

PLATE XI

Mandibles of:

Fig. 32. *Nasutitermes* (*Angularitermes*) *nasutissimus* Emerson. a. Imago or worker-type. b. Penultimate soldier. c. Soldier.

Fig. 33. *Nasutitermes* (*Subulitermes*) *kirbyi* Snyder. a. Imago or worker-type. b. Penultimate soldier (left). c. Penultimate soldier (right). d. Soldier.

Fig. 34. *Nasutitermes* (*Convexitermes*) *clevelandi* Snyder. a. Imago or worker-type. b. Penultimate soldier. c. Soldier.

Fig. 35. *Nasutitermes* (*Nasutitermes*) *corniger* Motsch. a. Imago or worker-type. b. Penultimate soldier. c. Soldier.

Fig. 36. *Nasutitermes* (*Nasutitermes*) *columbicus* Holmgren. a. Imago or worker-type. b. Penultimate soldier. c. Soldier.

Fig. 37. *Nasutitermes* (*Nasutitermes*) *pilifrons* Holmgren. a. Imago or worker-type. b. Penultimate soldier. c. Soldier.

Fig. 38. *Nasutitermes* (*Nasutitermes*) *ephratae* Holmgren. a. Imago or worker-type. b. Penultimate soldier. c. Soldier.

Fig. 39. *Nasutitermes* (*Constrictotermes*) *cavifrons* (Holmgren). a. Imago or worker-type. b. Penultimate soldier. c. Soldier.

Fig. 40. *Nasutitermes* (*Uniformitermes*) *barrocoloradensis* Snyder. a. Imago or worker-type. b. Penultimate minor soldier. c. Minor soldier. d. Penultimate major soldier (left). e. Major soldier.

Fig. 41. *Nasutitermes* (*Velocitermes*) *beebei* Emerson. a. Imago or worker-type. b. Penultimate minor soldier. c. Minor soldier. d. Penultimate major soldier. e. Major soldier.

Fig. 42. *Nasutitermes* (*Ceylonitermes*) *escherichi* (Holmgren). a. Imago or worker-type. b. Penultimate soldier. c. Soldier.

Fig. 43. *Nasutitermes* (*Trinervitermes*) *bettonianus* (Sjöstedt). a. Imago or worker-type. b. Minor soldier. c. Penultimate major soldier. d. Major soldier.

PLATE XII

Mandibles of:

Fig. 44. *Cubitermes fungifaber* (Sjöstedt). a. Imago or worker-type. b. Penultimate soldier. c. Soldier.

Fig. 45. *Procubitermes niapuensis* Emerson. a. Imago or worker-type. b. Penultimate soldier. c Soldier.

Fig. 46. *Cavitermes tuberosus* (Emerson). a. Imago or worker-type. b. Penultimate soldier. c. Soldier.

Fig. 47. *Orthognathotermes wheeleri* Snyder. a. Imago or worker-type. b. Penultimate soldier. c. Soldier.

Fig. 48. *Termes* (*Termes*) *panamensis* Snyder. a. Imago or worker-type. b. Penultimate soldier. c. Soldier.

Fig. 49. *Capritermes* (*Neocapritermes*) *angusticeps* Emerson. a. Imago or worker-type. b. Penultimate soldier. c. Soldier.

Fig. 50. *Capritermes* (*Capritermes*) *minor* (Holmgren). a. Imago or worker-type. b. Penultimate soldier. c. Soldier.

PLATE XIII

Mandibles of:

Fig. 51. *Amitermes* (*Amitermes*) *medius* Banks. a. Imago or worker-type. b. Penultimate soldier. c. Soldier.

Fig. 52. *Cylindrotermes macrognathus* Snyder. a. Imago or worker-type. b. Penultimate soldier. c. Soldier.

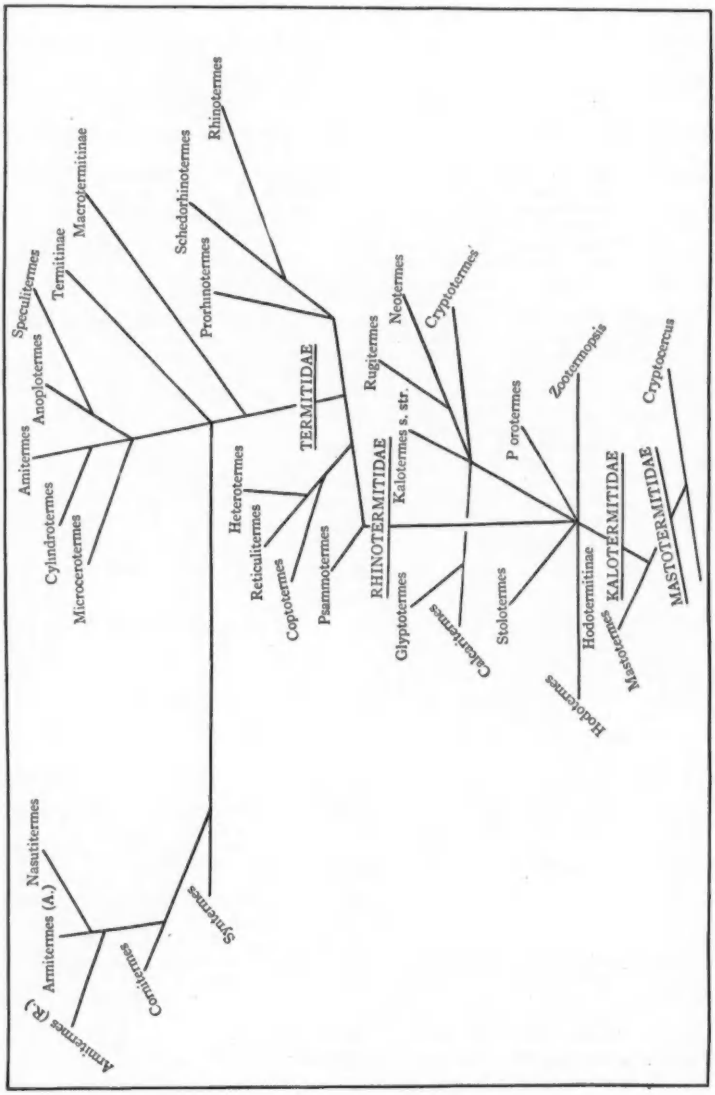
Fig. 53. *Anoplotermes* (*Anoplotermes*) *gracilis* Snyder.

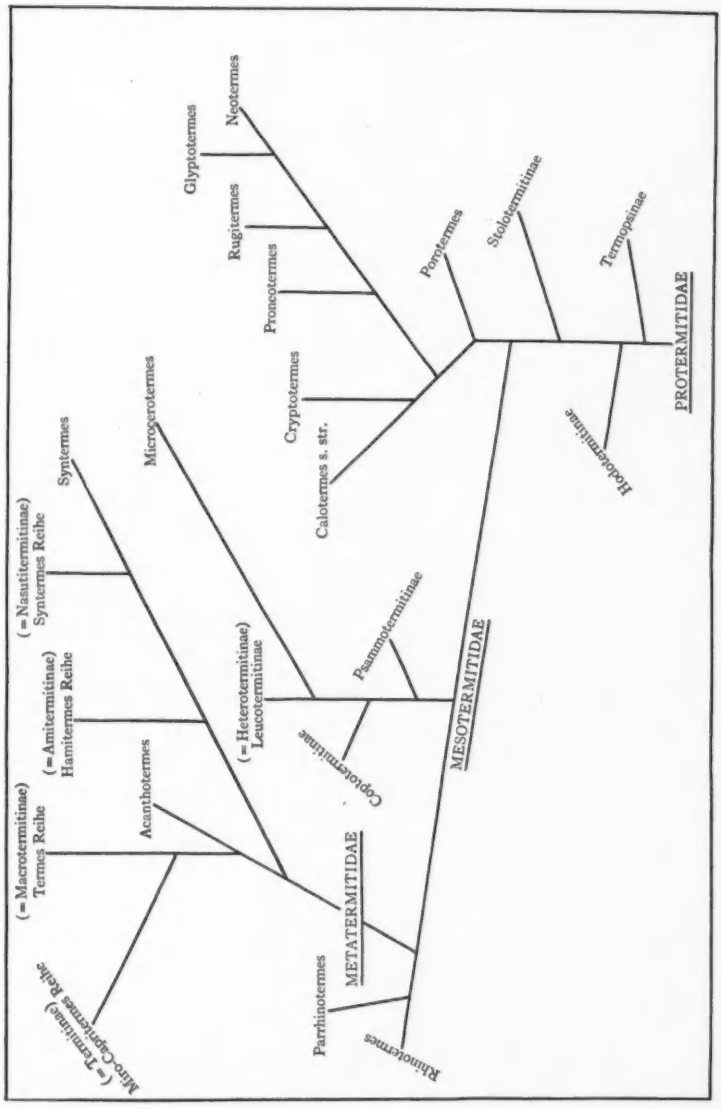
Fig. 54. *Anoplotermes* (*Speculitermes*) *arboreus* Emerson.

Fig. 55. *Microcerotermes arboreus* Emerson. a. Imago or worker-type. b. Penultimate soldier. c. Soldier.

Termite Phylogeny
Laura Hare

PLATE I

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Rugitermes
Proneotermes
Cryptotermes
Calotermes s. str.
Porotermes
Stolotermitinae
Termopsinae
Hodotermitinae
PROTERMITIDAE
Microcerotermes
Syntermes
(= Nasutitermitinae)
Syntermes Reihe
(= Amitermitinae)
Hamitermes Reihe
(= Heterotermitinae)
Leucotermitinae
Psammotermitinae
Coptotermitinae
MESOTERMITIDAE
(= Macrotermitinae)
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(= Termitinae)
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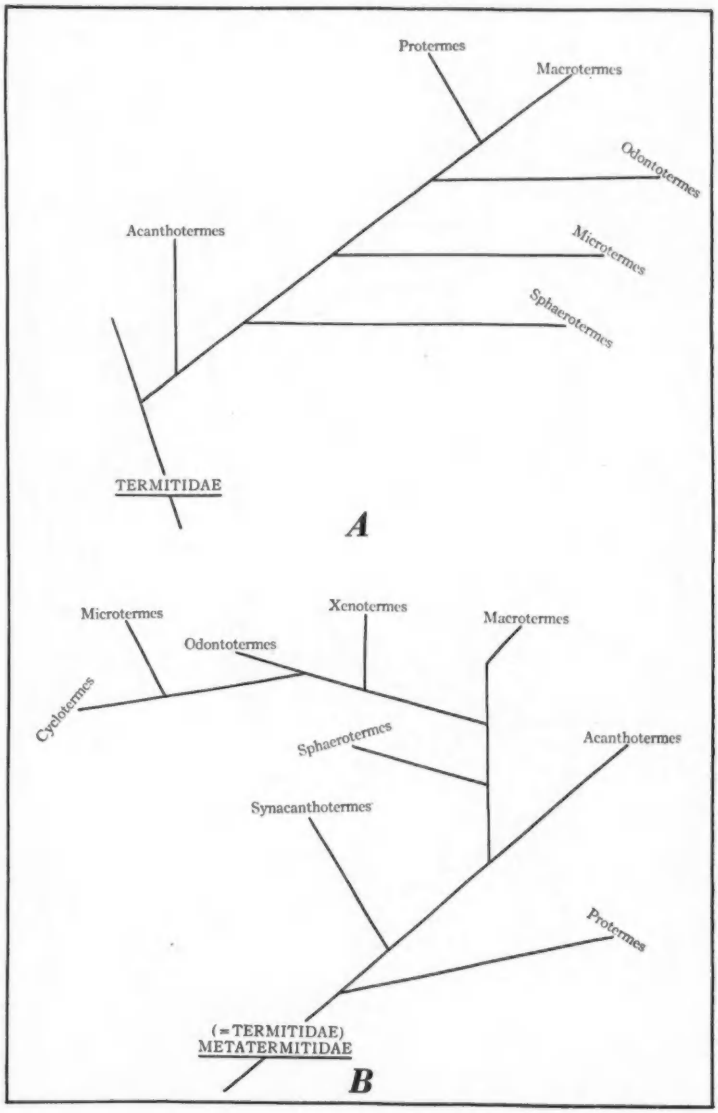
Parrhinotermes
Rhinotermes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Microtermes
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Macrotermes
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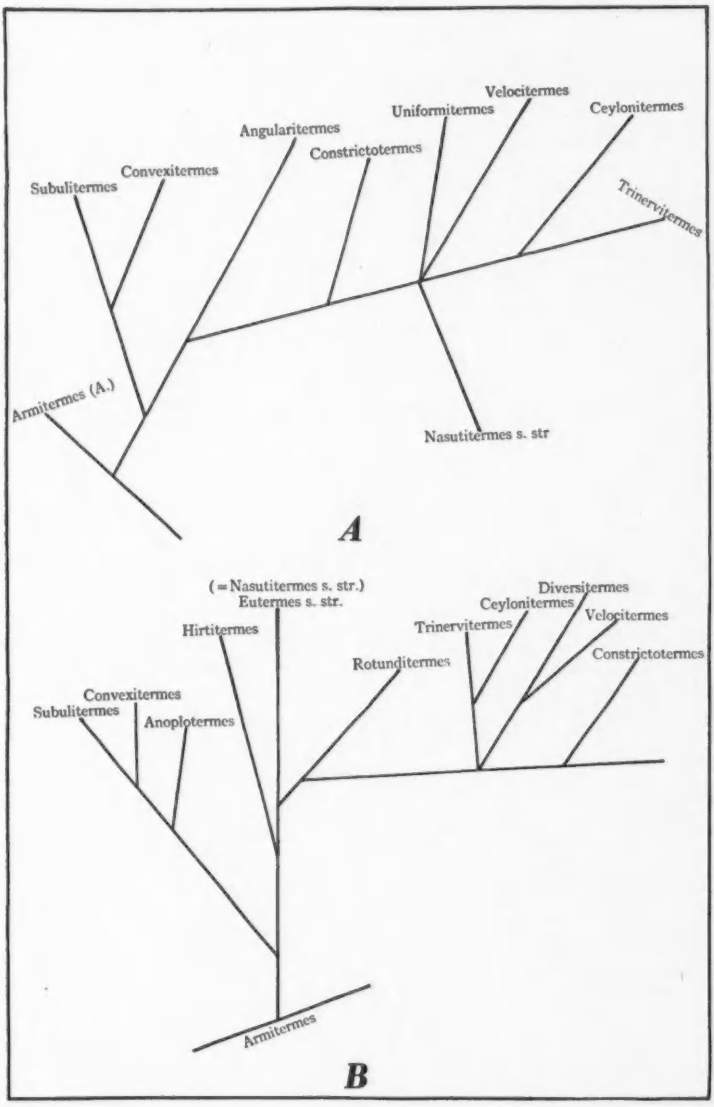
Synacanthotermes
Protermes
(=TERMITIDAE)
METATERMITIDAE
B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Ceylonitermes
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Constrictotermes
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Subulitermes
Trinervitermes
Armitermes (A.)
Nasutitermes s. str
A
(=Nasutitermes s. str.)
Eutermes s. str.
Diversitermes
Ceylonitermes
Hirtitermes
Trinervitermes
Velocitermes
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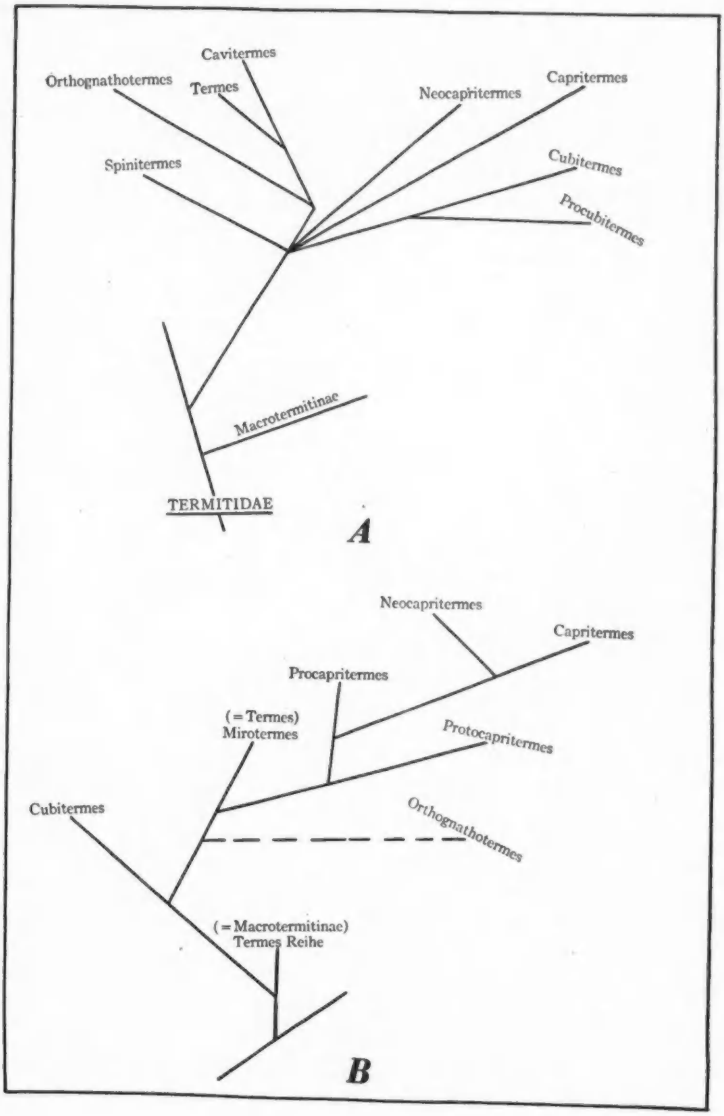
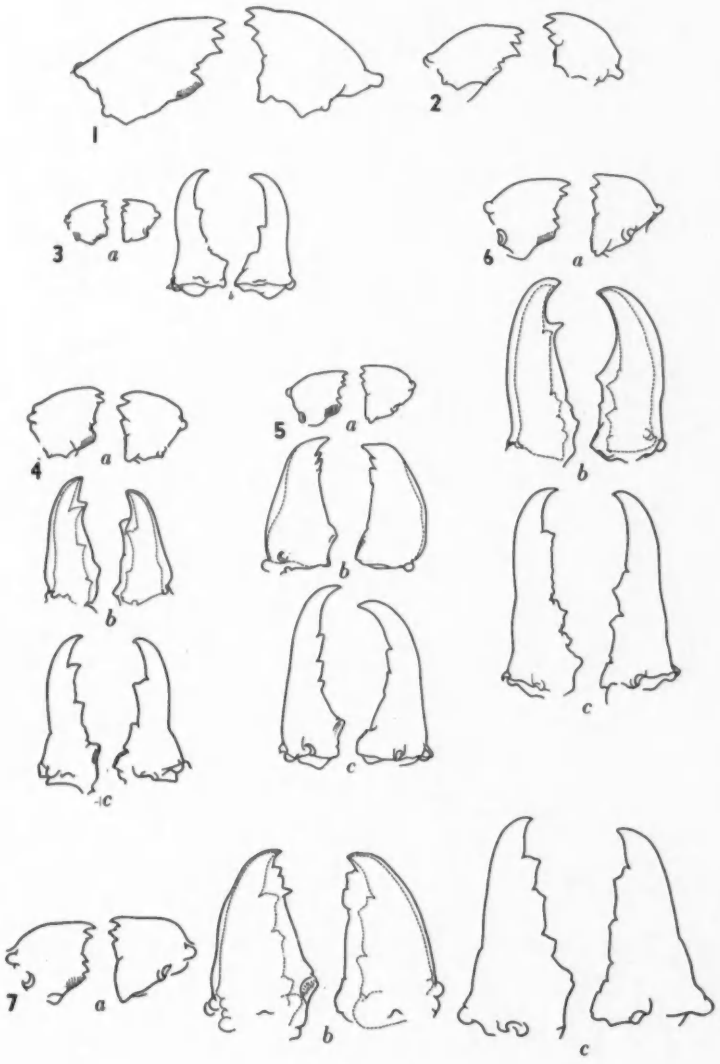
Armitermes
B

Termite Phylogeny
Laura Hare

PLATE V

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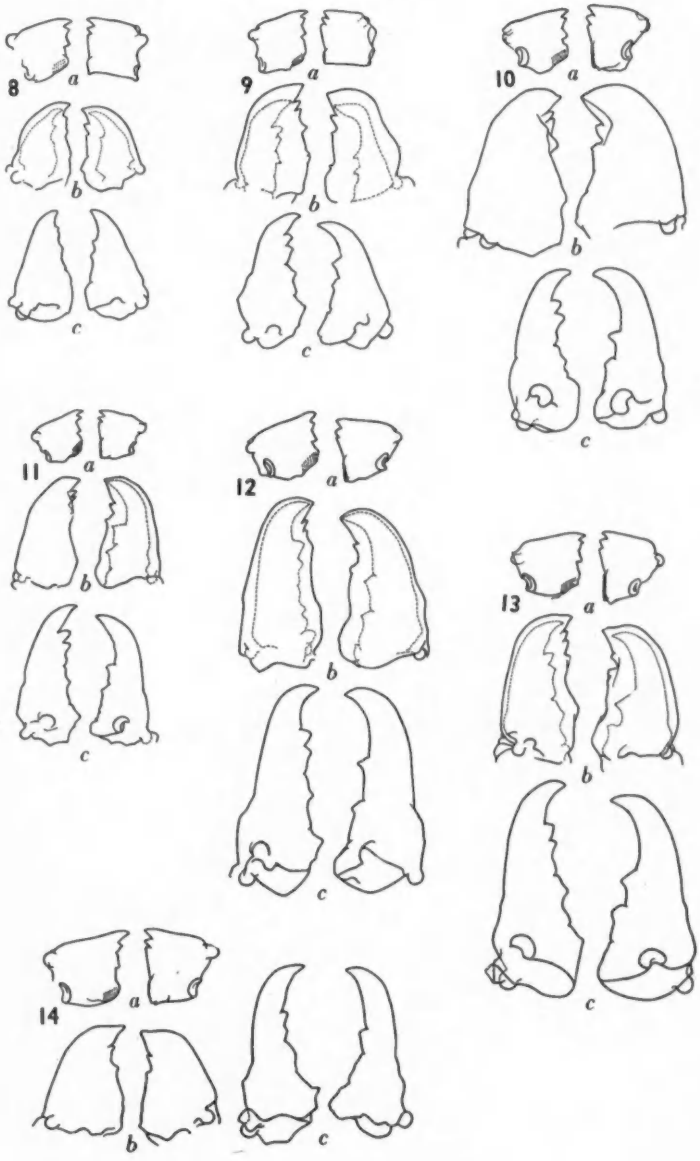
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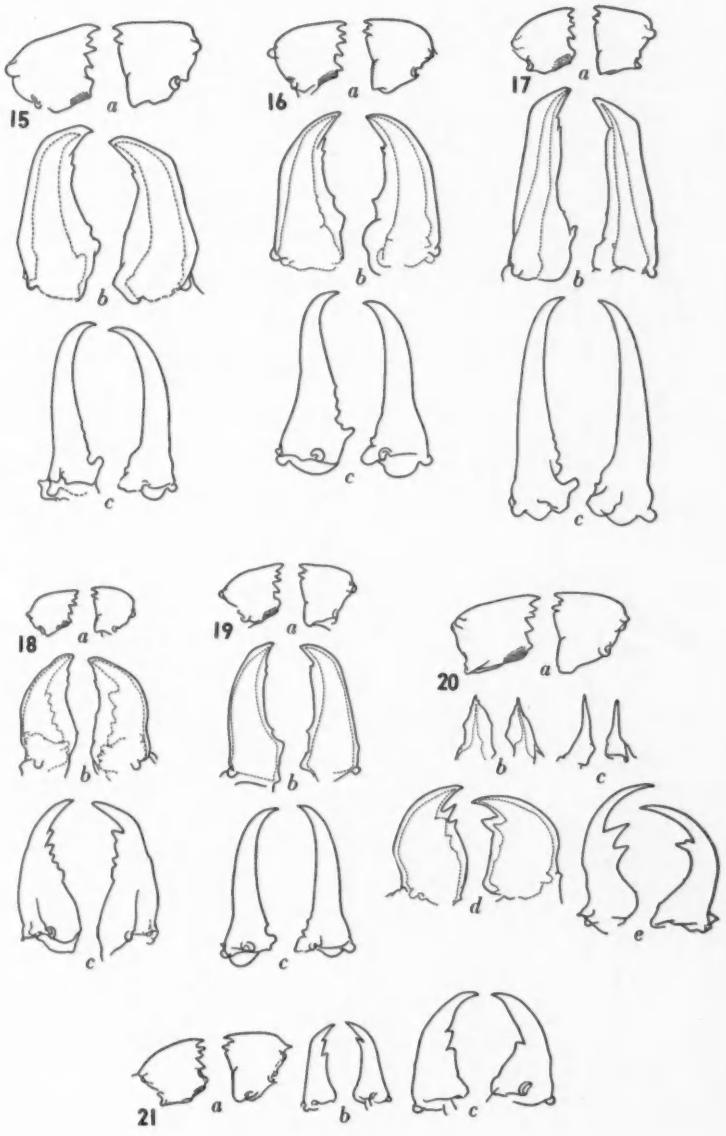
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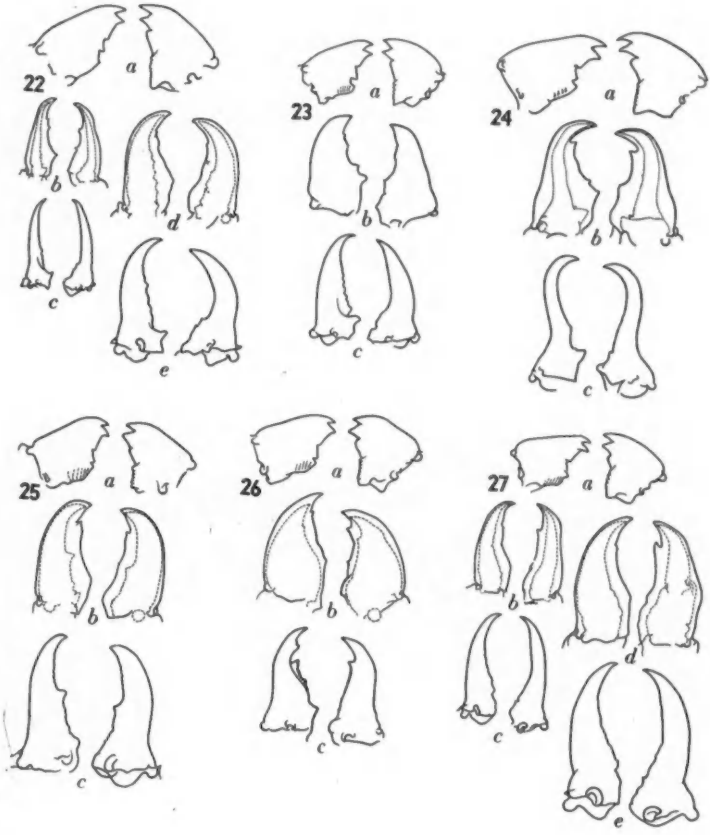
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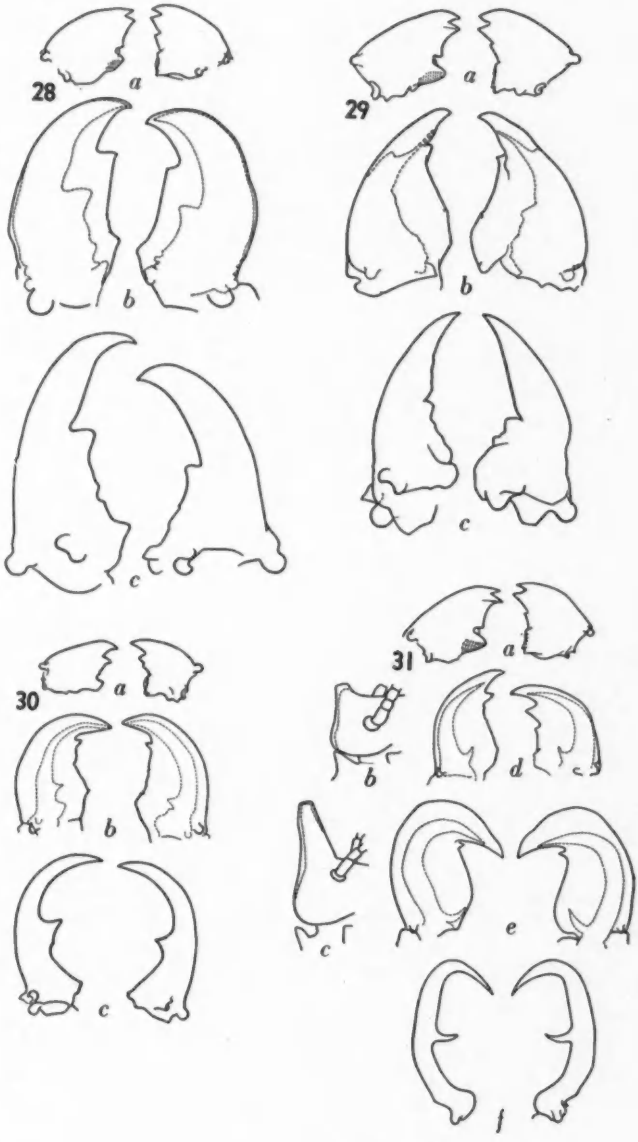
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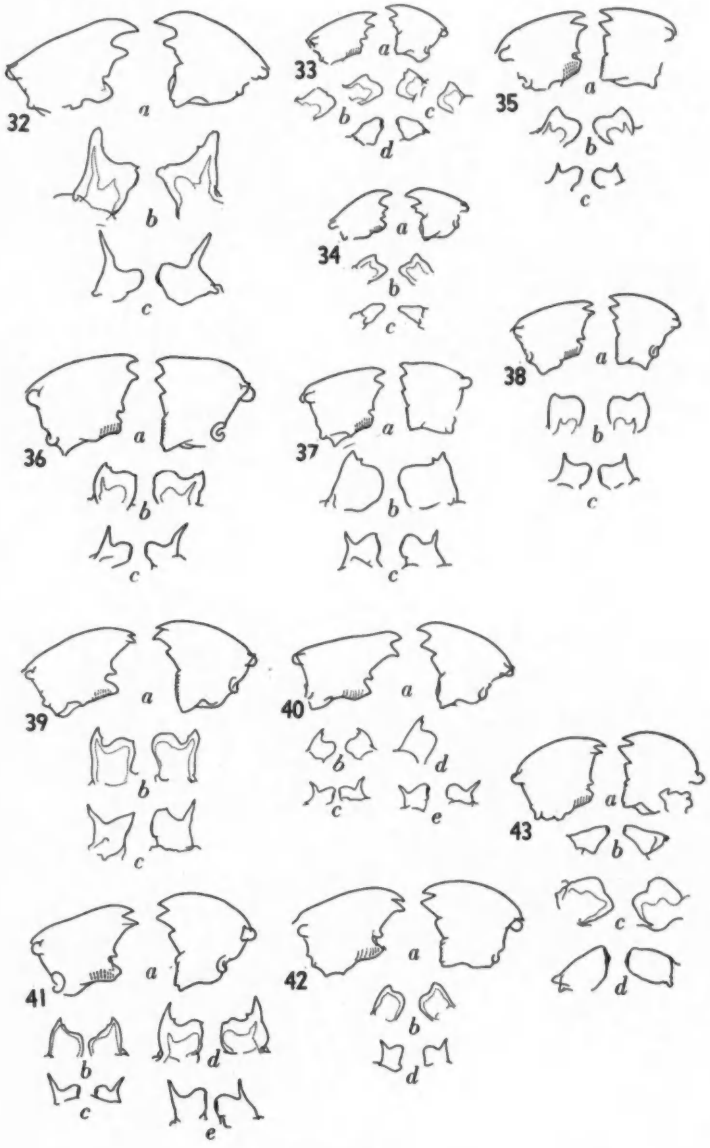
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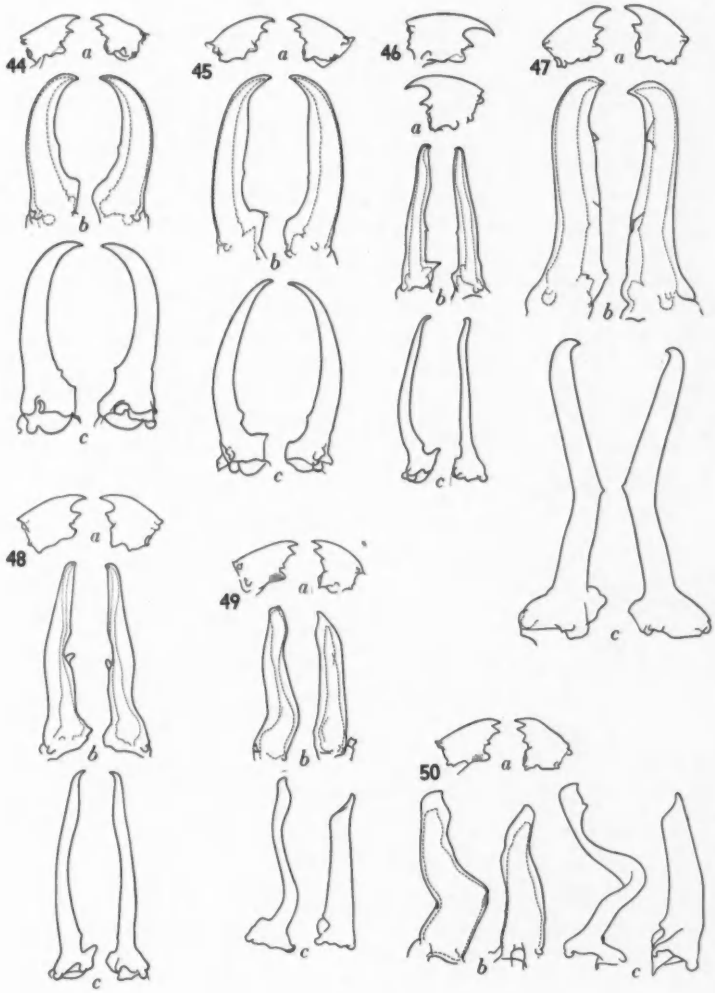
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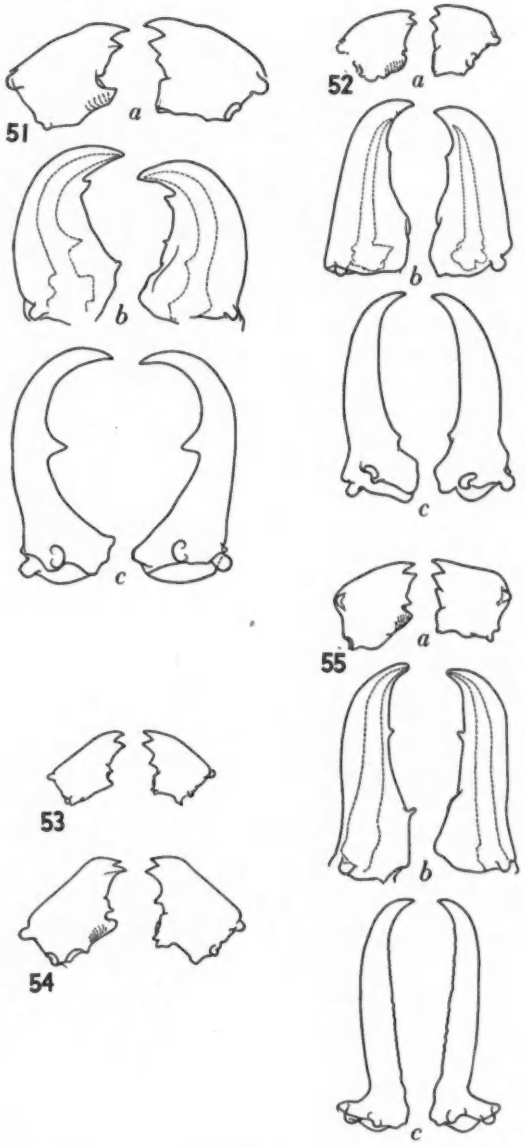
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THE POSTERIOR STIGMATIC APPARATUS OF TRYPETID LARVAE

F. H. Butt,
Cornell University, Ithaca, New York

This investigation was undertaken to describe the external and internal morphology of the posterior stigmatic openings. The stigmata differ in each species which makes them important characters in the identification of dipterous larvae. Little has been written about them morphologically. Most of the literature has dealt with the gross anatomy of the larva giving merely a description of the external appearance of the stigmata.

Keilen and Picado (1914) described them very briefly saying that the peristigmatic glands probably opened at the base of the hairs. De Meijere has discussed them in various papers and in one paper (1914) included some drawings which however, showed very little of the internal anatomy. Snodgrass (1924) has given the best description up to date but here again the description was very short.

MATERIALS AND TECHNIQUE

In preparation for this study larvae[1] were dehydrated in Cellosolve and Butyl alcohol; then embedded in rubber paraffin. Sections were cut at 6 and 8 microns. Some series were stained with iron haemotoxyln and counter-stained with eosin, but in these sections the cuticula did not appear well defined. Others were stained with Mallory's connective tissue stain. When this stain is used the exocuticula is colored a deep violet or a brownish yellow where sclerotized. The endocuticula is stained a brilliant blue.

The principal air ducts of dipterous larvae are the two enlarged dorsal tracheae that connect the anterior and posterior spiracles. Each of these tracheae opens caudally into an enlarged chamber, the atrium, or stigmatic chamber (fig. 1, st. c.).

The stigmatic chamber divides caudally into three broad lobes which extend through the thick endocuticula toward the exterior. They end in long narrow cylindrical chambers lying parallel to the surface of the body wall as shown in figure one. The walls of the cylindrical chambers are practically cut away on the inner half of the cylinder except for bars which connect the two sides. Figure seven is a diagrammatic drawing showing the inner side of one of the chambers as it would appear if removed from its position in the cuticula. Some

[1]Material for this study was furnished by Mrs. M. E. Phillips from her collection of Trypetid larvae since live specimens were not available.

of the bars are branched as shown, but most of them are single. These bars are shown in figure two as they appear from the surface and in figure five (B) in a longitudinal section through one of the chambers.

The opening to the exterior is a narrow slit in the outer side of the cylinder (fig. 6). The lips of this slit are equipped with sharp spines that curve toward the opposite side of the opening. Figure two is a surface view showing these openings and figure three is a cross-section through the three cylindrical chambers. The spines, the walls of the cylindrical chamber, and the bars across the inner opening are all composed of heavily sclerotized exocuticula.

In papers dealing with the Trypetidae, illustrations of the stigmata sometimes show the bars and spines in the same plane as though they both lie across the same opening into the cylindrical chamber. A study of serial sections as illustrated in figure five indicates that they lie in different planes and are located in opposite sides of the cylindrical chamber.

Snodgrass (1924) says that the cylindrical chambers are open the full length of their outer surface and at both ends. A study of whole mounts and of longitudinal sections through the cylindrical chamber indicates that the chamber is open at the outer end only, the inner end being closed and heavily sclerotized (fig. 2).

The external openings lie in a nearly horizontal position almost parallel but converging somewhat toward the center line of the larva. They are located in an oval area called the stigmatic plate (fig. 2, st. pl.). Near the inner side of the stigmatic plate and about equi-distant from the ends of the outer slits is a thickening of the cuticula known as the stigmatic scar (fig. 2, sc.). It marks the spot where the old tracheal apparatus of the previous instar was thrown off during the last molt. On each stigmatic plate are four sets of branched hairs surrounding the slits as shown in figure two. They are processes of the exocuticula. From the sections cut for this study it could not be ascertained whether they were connected with glandular openings or were sense hairs.

The stigmatic plate has never been clearly described. Snodgrass applied this term to the narrow heavily chitinized border of the external openings. He says, "Each plate is a cylindrical chitinous structure at the end of a wide lobe of the stigmatic chamber." Thus he calls the cylindrical chambers "stigmatic plates." Others apply it to the area enclosing the three slits as shown in figure two. In mounted and cleared specimens the stigmatic plates are plain to be seen set off by boundary lines that are specially distinct laterally (fig. 2). However, these boundary lines are not sutures as a study of cross-sections will show. The posterior stigmata are located on the flattened ends of two small projections of the body wall. These flat areas, oval in shape, are the stigmatic plates. As shown in figure eight, the lateral edges of the plates are raised much higher from the body wall than are the inside edges. Figure four is a cross-section through two of the cylindrical chambers cut near the outer side of the stigmatic plate on the highest part of the projection of the body wall. This figure demonstrates clearly that the chitinous exocuticula of the plate is continuous with that of the body wall, no sutures being present.

THE FILTERING APPARATUS

The outer spines and the inner bars of the cylindrical chambers serve to prevent coarse foreign materials from entering the inner stigmatic chamber and the tracheae, but they are not small enough to prevent finer particles from passing through the cylinders into the stigmatic chambers. This dirt is prevented from going any farther by a filter formed of modified exocuticula which fills up the outer end of the stigmatic chamber (fig. 3; fig. 5, F). The exocuticula of the filter forms a spongy mass usually filled with cell-like vacuoles in its center. Heavy spine-like extensions of the endocuticula project into the filter probably acting as supports. In some specimens studied, so much dirt had been taken into the stigmatic chamber that a large part of the filter was broken away (fig. 3) leaving cavities between the filter and the cylindrical chambers. Some of the material of the filter in such cases is left on the walls of the cavity giving them the appearance of being striated.

THE GLANDS OF THE POSTERIOR STIGMATA

The glands surrounding the posterior stigmata are of the typical unicellular type, modified from epidermal cells. They are greatly enlarged and are located inside the epidermal layer although they maintain a connection with the epidermis by means of the gland ducts to the exterior. The nucleus of one of these cells is very large with large chromatin masses and a nucleolus. The cytoplasm in some glands is vacuolated while in others it appears very dense. Fine ducts radiating like the ribs of a fan throughout the cytoplasm from the end of the main duct can often be seen. The main duct penetrates the epidermis and the endocuticula to empty into the outer end of a cylindrical chamber. There are six of these glands in all, one for each cylindrical chamber.

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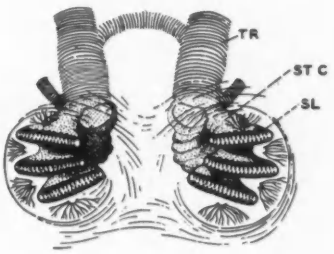
EXPLANATION OF PLATE

Fig. 1. Diagram of posterior stigma of mature larva. (After Snodgrass).
Fig. 2. Surface view of a stigmatic plate.
Fig. 3. Longitudinal vertical section through the stigmatic chamber showing cross-sections of the three cylindrical chambers.
Fig. 4. Longitudinal vertical section through the outer ends of two cylindrical chambers showing the gland ducts.
Fig. 5. Longitudinal-horizontal section through the stigmatic chamber and one cylindrical chamber showing the gland duct ending in the cylindrical chamber.
Fig. 6. A diagram of the cylindrical chamber to show the outer slit.
Fig. 7. A diagram of a cylindrical chamber showing the bars across the inner opening.
Fig. 8. Perspective drawing of the caudal end of an apple maggot to show the position of the stigmatic plates on the ends of cuticular projections.

ABBREVIATIONS

B.....bars across inner opening in cylindrical chamber.
C.C.....cylindrical chamber
C. P.....noncellular cuticular processes or hairs.
E N C T..endocuticula.
E. P.....epidermis, epidermal cells.
E X C T..exocuticula.
F.....filter material or reticulum.
GL.....epidermal gland.
GL. D...epidermal gland duct.
SC.....stigmatic scar.
SL.....stigmatic slit
ST. C...stigmatic chamber.
ST. PL..stigmatic plate (not stigmatic plate of Snodgrass).
T.....taenidia.
TR.....trachea.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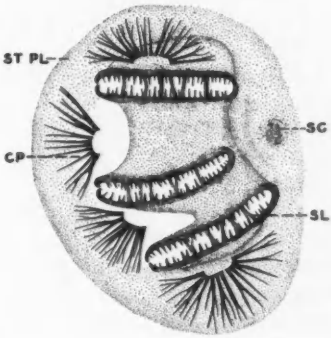
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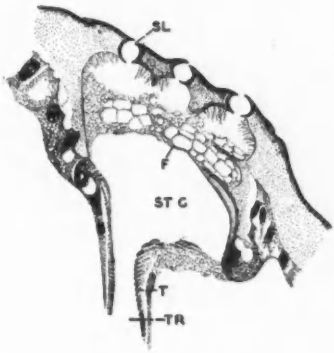
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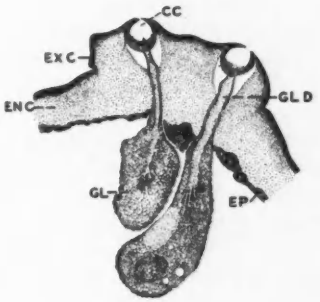
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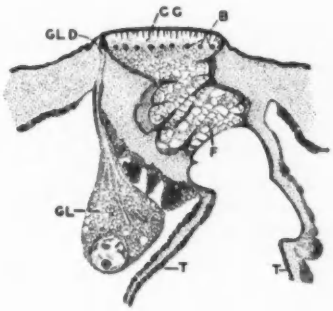
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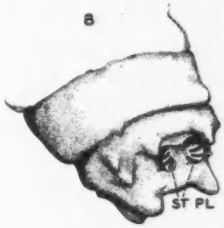
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THE SPECIES OF THE SUBGENUS KERTESZIA OF ANOPHELES

(Diptera, Culicidae)

W. H. W. Komp,
Medical Entomologist, U. S. Public Health Service[1]

This subgenus of Anopheles, which contains a small but interesting group of mosquitoes which breed in the water in bromeliads, and more rarely in bamboo, has been, taxonomically speaking, in rather a chaotic condition in the past. This has been due in part to inaccurate observation of specific characters, in part to the variability of color-markings in the species, and partly to lack of adequate material for study.

Recent observations and collections made by the author have, it is hoped, helped to clarify the nomenclature in this group, and to define and delimit to some extent the distribution of the species. The author has authentic material, larvae, males and females, of all the hitherto known species, and recently collected three new species in Colombia. On the basis of his observations and collections, it seems that there are at least 7 valid species in the group, instead of 2, with their subspecies, as stated by F. W. Edwards (1), or 3 species, as stated by Dyar (2). Three of these species, *Anopheles* (*Kerteszia*) *boliviensis* Theobald 1905, *Anopheles* (*Kerteszia*) *bellator* D. & K. 1906, *Anopheles* (*Kerteszia*) *cruzii* D. & K. 1908, have been recognized as valid species by Dyar; another species, *Anopheles* (*Kerteszia*) *neivai* H. D. & K. 1917, relegated to the synonymy of *cruzii* by both Dyar and Edwards, will be shown to be valid; in addition, 3 species, all collected in Colombia by the author, will be described as new on the basis of larval characters, characters of the male terminalia, and color-markings of the adult.

The observations on which the author bases his conclusions, together with an analysis of the nomenclature, form the subject of this paper.

A word may not be out of place here on the material before those who have described the various species, their findings from such material, and the methods and material used by the author in coming to his conclusions.

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[1]From the Gorgas Memorial Laboratory, H. C. Clark, Director, Panama City, Rep. de Panama.

The genotype of the group, *Anopheles* (*Kerteszia*) *boliviensis* Theobald, was described from a single female collected in Bolivia, South America, in 1905 (3). No other similar material was collected until 1911, when C. H. T. Townsend collected a series of 10 female specimens from Huarascaray and Rio Charape along the eastern slope of the Peruvian Andes (4). This series is in the U. S. National Museum. The male and larva were found in Restrepo, Colombia, in 1935, and were described by the author and Dr. E. Osorno M. in 1936 (5). The mesosome of the male is without leaflets.

Anopheles (*Kerteszia*) *cruzii* was described by Theobald in 1901 (6) under the name *Anopheles lutzii*. As this name was preoccupied, the name *cruzii* was proposed by Dyar and Knab in 1908 (7). The type locality is Rio de Janeiro, Brazil, from which Dr. Lutz sent Theobald 3 female specimens. Other specimens, apparently the same, were taken at São Paulo, Brazil, by Dr. Lutz; no males of this species were described. Dyar's description of the male (8) was probably taken from a specimen of some other species which he "lumped" under the synonymy of *cruzii*. As he thus relegated *neivai* to *cruzii*, it is probable that he described what was actually the male of *neivai*. Dr. Alan Stone of the U. S. National Museum kindly informed me that no authentic male material from the type locality, Rio de Janeiro, Brazil, is in the U. S. National Museum. Lately, through the good offices of Dr. P. C. A. Antunes of the Staff of the Yellow Fever Service of the Rockefeller Foundation, a single male and the associated larval skin were presented to the author, the locality being São Paulo, Brazil, from whence also Dr. Lutz sent specimens to Theobald. On mounting the male terminalia, the writer found them quite distinct, and not at all like Dyar's purported description, in that the mesosome possessed a pair of slender tubular leaflets.[2]

Anopheles bellator D. & K. was described from Trinidad, British West Indies, in 1906 (9). The original description does not mention whether males were among the types, but in 1917 Howard, Dyar and Knab (10) described the male of this species. The state of the art at this time may be judged by the fact that

[2]Since the preparation of this paper, material of *A. cruzii* has been received rom Dr. A. da Costa Lima, from Angra dos Reis, State of Rio, Brazil, and Dr. P. C. A. Antunes, from Campos do Jordão, State of São Paulo, Brazil, altitude 1600 meters. The male terminalia of these specimens have long, backwardly directed leaflets on the mesosome, and in other respects correspond to the description of *A. cruzii* as here given.

the mesosome is not mentioned in the description of the male terminalia, nor is it shown in the figure 256 of the same work. Root (11) says "the genitalia (of *bellator*) agree in every detail with those of *Anopheles neivai*, so far as I could see." Root probably was examining a poor mount of *bellator*, in which the mesosomal leaflets which are present were not apparent.

The writer visited Trinidad in the summer of 1936, and collected large numbers of *Anopheles bellator*. Larvae were found in bromeliads, and several males from associated larvae were obtained. These had distinct tubular leaflets on the mesosome, well down from the tip.[3]

Anopheles neivai Howard, Dyar and Knab, was described from 2 females from Porto Bello Bay, Panama, in 1917 (12). Dr. Stone reports that the mounted terminalia of a single male from Costa Rica is in the U. S. National Museum collection. Root (13) (14) described the male terminalia and larva quite accurately, giving a recognizable figure of the former. Root's material is stated to have come from Panama. The writer has collected many larvae and pupae from bromeliads, both terrestrial and arboreal, in Panama, and has abundant material of all stages of the species. *Anopheles neivai* is the only species of the group *Kerteszia* that has been found in Panama. The mesosome of the male is without leaflets.

Summarizing this information, it can be said that *boliviensis*, *bellator*, *cruzii* and *neivai* were all originally described from females alone. What purports to be a description of the male terminalia of *Anopheles cruzii* by Dyar (2) was actually a description of *Anopheles neivai*, as Dyar had no authentic male from Brazil. No description of the male terminalia from Brazilian specimens is known to the writer.

The male terminalia of *bellator* are likewise incorrectly described by Dyar (2), as the description is word for word the same as that of the male terminalia of *cruzii* (described from *neivai* male) on the preceding page, and no mention is made of the mesosomal leaflets present in *bellator* from the type locality, Trinidad. No correct description or figure of the male terminalia of *bellator* is known to the writer.

The male terminalia of *Anopheles neivai* were inadequately

[3]A single male specimen collected by Dr. H. W. Kumm, at Caravellas, State of Bahia, Brazil, and forwarded through the kindness of Dr. D. B. Wilson, of the Rockefeller Foundation laboratory at Rio de Janeiro, extends the range of *A. bellator* considerably to the southward along the Brazilian coast.

described in the original description (10), but Root (13) figures them correctly. So it is evident that of the four species discussed, the true males of only two, *boliviensis* and *neivai*, have been known or adequately described.

The situation is similar in the larvae. The larva of *boliviensis* remained unknown until 1936. The larva of *bellator* which Dyar purported to describe (2) was really the larva of *neivai*, as may be seen from the description of the single elements of the palmate hairs. As this description is word for word the same as that of *cruzii*, which differs from the larva of *neivai*, Dyar's purported description of *cruzii* is incorrect. The larva of *cruzii* was correctly described by Peryassú (15) in 1908, the locality being Ilha Grande, Brazil. The larva of *neivai* was correctly described by the authors of the species in the original description (12). Thus the larva of *Anopheles bellator* is undescribed; no modern description of the larva of *Anopheles cruzii* is available; the larvae of *neivai* and of *boliviensis* have been adequately described

In addition to the valid species mentioned, Dyar and Knab erected several species and races, on females alone, all of which Dyar later relegated to the synonymy of *cruzii* (16) and *bellator*. These are *hylephilus* D. & K., described from what we now know to have been a mixture of species, from specimens taken in Venezuela, Ecuador, and Panama (17). Race *bromelicola* Dyar was described from females from Venezuela, and is probably only a variety of *bellator*. Without males, it is impossible to state with certainty to which valid species these two forms should be referred. Probably *hylephilus* is a mixture of *neivai* and some other species, while race *bromelicola* is probably *bellator*.

The subgenus *Kerteszia* was erected by Theobald in 1905, with *Anopheles* (*Kerteszia*) *boliviensis* as the genotype, by original designation. As the species possessed abdominal scales, and, as Theobald used scale-characters extensively in defining genera, Dyar (18) believed it necessary to erect a separate subgenus, *Dendropaedium*, for the bromelicolous *Anopheles* species which did not possess such abdominal scales. Later Dyar (19) abandoned this subgenus, as he stated "Christophers has shown that *Dendropaedium*, the name proposed for the bromelicolous species, falls to *Kerteszia*" (20).

In the papers already published by the writer on the species collected during an entomological survey in Colombia (21) (5) several errors in the nomenclature of the *Kerteszia* species found

must be corrected on the basis of later knowledge. In the first paper, the reference to *boliviensis* (p. 68) is correct. The reference to *bellator* refers to three species, here described as *bambusicolus*, *homunculus*, and *anoplus*. The Panama species mentioned is *neivai*, not *cruzii*. *Bellator* was not found in Colombia. In the second paper (p. 419) the name *bellator* should be changed to *neivai*, throughout.

It is now well established that the basis of classification of the Anophelini rests upon the characters of the male terminalia. Many species of *Anopheles*, indistinguishable in the adult female, are easily separable on the characters of the male terminalia. Examples from the Old World fauna are *Anopheles aitkeni* James and *Anopheles insulaeflorum* Swellengrebel and Swellengrebel, indistinguishable in the adult female, but separable on characters of the mesosome of the male. *Anopheles tarsimaculatus* Goeldi and *Anopheles strodei* Root are examples from the neotropical fauna.

MALE GENITALIA IN KERTESZIA

As many of the author's conclusions are based on a study of the male terminalia, it may not be out of place to describe the appearance of these parts in the *Kerteszia* group, and to show the necessity for adequate dissection of the parts, so that the distinguishing characters of the mesosome and claspette lobes may be seen.

The arrangement of the spines on the sidepiece is characteristic of the group. There is a single long, slender, sinuate parabasal spine from a tubercle near the inner dorsal margin of the sidepiece, at the base. The paired accessory spines have migrated well above their usual position near the middle of the sidepiece, and are situated well beyond this point, on the dorso-internal aspect. The single internal spine is much thicker than usual, and has migrated towards the base from its usual position, and lies on the ventral aspect of the sidepiece, between the distally placed accessory spines and the basal parabasal spine. The anal lobe is high and conical, with many parallel ridges in the membrane; the paraprocts are not very heavily sclerotized. The ninth sternite has a form characteristic of the group, as it is broad, with a median inwardly-directed ridge, and a deep semicircular emargination on each side of it, so that the distal margin shows three points. The mesosome may be without leaflets, or it may have a pair of slender tubular leaflets, attached

either near the tip, or some distance below it, and usually directed ventrally (away from the anal lobe). The dorsal lobes of the claspette consist of a tubular column, at whose tip are two sets of long, slender, sinuate, contorted leaflets. The ventral lobe is variable in form, being characteristic in most cases of the species. It is usually composed of two flattened plates, very hairy towards the tip, which is usually somewhat expanded. The ventral lobe is so situated that its plane is at right angles to the cover-glass, if a whole mount of the terminalia is made. Therefore, the true shape of the ventral lobe cannot usually be made out in such mounts. The author has been able to dissect out these characteristic parts, so that their actual form can be seen, and to photograph them. The separation of the various species, of which the male is known, becomes relatively easy when the parts are dissected out; without such dissection it is oftentimes impossible to see the true form of the ventral claspette lobes, and sometimes even the mesosomal leaflets may be obscured among the folds of the anal lobe. As the color-characters of the species are variable, and as several species resemble each other closely in external characters, it is necessary to resort to the characters of the terminalia for correct determination. Without adequate dissection, little can be seen of the distinguishing characters of the mesosome and ventral claspette lobes, and determinations based on whole mounts of the terminalia are a matter of guesswork. To emphasize this point, the reader is referred to the descriptions of two new species contained in this paper, *Anopheles* (*Kerteszia*) *homunculus*, and *Anopheles* (*Kerteszia*) *anoplus*, which are separable only on the combined characters of the mesosome and ventral claspette lobes.

NOTES ON THE LARVAE OF KERTESZIA

The larvae of the seven species here treated are known. The larvae of *cruzii*, *bellator*, *homunculus*, sp. n. and *anoplus*, sp. n. are very similar in all particulars. As is usual in the larvae of Anopheles breeding in restricted habitats, such as tree-holes (e. g., *A. barberi*), the head-hairs are simple, rarely branched at tip. The antennae have the hair simple, well down towards the base, and on the dorso-external aspect. Palmate hairs are absent on the metathorax, and may be present, or absent (*neivai* and *boliviensis*), on the first abdominal segment. The single elements of the palmate hairs are lanceolate and sharp-

pointed in all species except *neivai*, in which the tips are truncate. The form of the palmate tufts approaches that found in the common species of *Nyssorhynchus*, but differs in that there is a long, conical, calyx-like base, from which the relatively short elements arise (except in *bambusicolus*). In most balsam mounts the elements are not expanded, forming a rosette, as is ordinarily the case in *Nyssorhynchus*, but are usually contracted, giving a brush-like appearance to the tuft; in such cases the elongate conical base is well displayed.

The lateral abdominal hairs on the 4th, 5th, and 6th segments are long, simple and lightly feathered. Long lateral hairs are also present on segment 7.

The pecten is small, with about 18–20 teeth, long, subequal and fringed, usually on both sides, with long spines. The spiracular apparatus is reduced, somewhat narrowed posteriorly, but normal in form. Hair No. 9, the long postspiracular hair, arising ventral to the dark bar connecting the pectens of the two sides, is simple (except in *bellator*).

NOTES ON THE ADULTS OF KERTESZIA

The adult females resemble each other very closely. They are all characterized by the peculiar markings of the mesonotum of the thorax, which has two wide median and two subdorsal bare black longitudinal lines, making four in all, impressed on a grayish integument, which is clothed with gray bristles. There is sometimes a very narrow median black line between the wider paired inner lines. The paired median lines from the anterior edge of the mesonotum extend more than half way posteriorly to the antescutellar space; the subdorsal lines do not quite reach the anterior border of the mesonotum, and extend to the posterior margin. Sometimes the anterior fossa is enclosed within a grayish line in the integument.

The wing-markings are variable, but when fully developed there are five white spots on the costal margin, and a white apical fringe-spot. The markings of the legs are also variable, particularly in the relative amounts of black and white on the hind tarsi. Melanotic forms are common, in which the white spotting of the wings is reduced, and in which the general color of the specimen is much darker than in other specimens taken at the same time.

As a matter of historical interest, Dyar's conclusions as recorded in 1923 (22) concerning the varieties of the bromelicol-

ous *Anopheles* known to him at the time are quoted: "I cannot determine more than one species of *Anopheles* in Bromeliaceae, with slight local variation. The whitish shading on the third vein is distinct in the southernmost form (*cruzii*), in which the tip of the fifth hind tarsal is white. In Trinidad, the white persists on the third vein, though fainter, while the fifth hind tarsal is dark (*bellator*). Coming westward, we find *hylephilus*, described from Venezuela, Ecuador and Panama. Eliminating the latter locality, we find the third vein dark, or with only the faintest trace of white, the costal spots of the wing of good size, the outer three reaching the costal edge. In Panama, the coloration is the same, except that the wing-spots tend to be small, often breaking away from the costal edge. In the type of *neivai*, the two basal spots have so broken away; but in another, only the second spot has done so, while in a third the outer spot is missing. There is no constancy in the character, and I am inclined to refer all the Panama material to *neivai*, including those formerly listed under *hylephilus*, among which is one of the types of *hylephilus*. The specimens from Costa Rica mentioned in the Monograph (Vol. IV, p. 988) are in too poor condition to make out the characters, while those from Mexico were not bred to the adult state."

Later Dyar (23) revised his opinion, stating that he believed that two species of bromelicolous *Anopheles* existed. (He apparently overlooked Theobald's *boliviensis*). In this paper he states that *hylephilus* is the normal form, of which *neivai* is an aberration. Yet, aside from minor variations in the spotting of the costa, the original descriptions are alike, both forms having a minute white spot at the base of the third vein, and both having the hind tarsal segments more than half white, with a black ring at the base of the 5th segment. Both forms were described from a few females. In the articles quoted Dyar gives the following key:

"Hind tarsi with the joints more white than black.
Third vein white except near base and tip.....*cruzii* D. & K.
Third vein dark.....Race *neivai* H. D. & K.
Hind tarsi with the joints more black than white.
Third vein white except near base and tip.....*bellator* D. & K.
Third vein dark except a few white scales.....Race *bromelicola*, new."

The records given in this article for *cruzii* we now know refer to a mixture of species. The only locality in the list of which we can be certain for *cruzii* is São Paulo, Brazil. The two Peruvian records are for *boliviensis* (see discussion of this species in the

present paper). The Surinam record probably refers to a new species, described in the present article under the name *anoplus*. The specimen from Manoa, Venezuela, cannot be referred to any known species with certainty. The material from Ecuador, Panama and Costa Rica is probably all *neivai*.

Following are discussions of the four known species, with references to the original descriptions; the salient distinctions between the species are given, and descriptions of the male terminalia, hitherto undescribed or incorrectly described, are given for *bellator* and *cruzii*. Three new species, *Anopheles* (*Kerteszia*) *homunculus* sp. n., *Anopheles* (*Kerteszia*) *anoplus* sp. n., and *Anopheles* (*Kerteszia*) *bambusicolus* sp. n., are described. Finally, keys to the adult females, male terminalia, and larvae, so far as they are known, are given.

ANOPHELES BOLIVIENSIS THEOBALD

During the course of an entomological survey made in the region around Restrepo, in the Intendencia of Meta, near Villavicencio, at the foot of the eastern slope of the Andes in Colombia, the writer found among material collected previous to his arrival, and later himself collected, female specimens of an *Anopheles* of the subgenus *Kerteszia*. On close examination, all these females were found to have dark scales, as well as hairs, on all the abdominal tergites except the first, and white scales on the sternites. Theobald (3) described *Anopheles* (*Kerteszia*) *boliviensis* in 1905, stating "Abdomen deep brown clothed with rather irregular large black scales and with deep brown lateral and posterior 'border-bristles'." The type locality is Songo, Bolivia. The Colombian material collected by the author differs slightly from Theobald's description, for he states that "the greater part of the second hind tarsal is white (a minute black base), the other hind tarsals dark brown"; in the Colombian material the second to fifth hind tarsal segments have broad black bases and narrow white tips. Among material in the collection of the U. S. National Museum, the writer found a series of 10 specimens of a species of *Kerteszia* from Huarascaray and Rio Charape, along the eastern slope of the Peruvian Andes, collected in September, 1911, by C. H. T. Townsend, then Entomologist for the Peruvian Government. These specimens agree with the writer's Colombian material and with Theobald's description of *Kerteszia boliviensis* in having abdominal scales. Knab (24), however, threw the nomenclature of the

group into initial confusion by overlooking these abdominal scales in Townsend's Peruvian material, and stated "the only observable difference between the Brazilian species (=*cruzii*) and those from Peru (=*boliviensis*) is that on the hind tarsi the black line along the dorsal surface of the first segment is somewhat heavier in the latter." He made *cruzii* a synonym of *boliviensis*, as *boliviensis*, being described earlier, had priority. This error was carried on through many articles by Dyar, and was never corrected with reference to the Peruvian material, as Dyar (18) in 1918, stated "*Kerteszia*, therefore is unknown to us in nature," although Townsend's material which has abdominal scales, was before him. In later papers, *cruzii* was recognized as a distinct species, not agreeing with Theobald's *boliviensis*, on the fact that *cruzii* did not possess abdominal scales.

We now have sufficient material (Townsend's, and the writer's, from Colombia) to state definitely that a species of *Kerteszia* with abdominal scales occurs along the eastern slope of the Andes; this is probably the species described by Theobald as *boliviensis*.

The hitherto unknown male and larva of this species were found near Restrepo, Colombia, and were described by the writer and Dr. E. Osorno M. in 1936 (5). The mesosome of the male terminalia is without leaflets. The shape of the ventral lobe of the harpago (claspette lobe) is characteristic of the species. The larva has abdominal palmate hairs on segments 2 to 7; with the single elements lanceolate, sharp-pointed, as in *cruzii* and *bellator;* the anterior external clypeal hairs are very stout and short in *boliviensis*, while they are slender like the anterior internal clypeal hairs in *cruzii*, *bellator*, and *neivai*.

ANOPHELES CRUZII DYAR AND KNAB

This species was described by Theobald in 1901, under the name *lutzi* (6). As this name was preoccupied by *A.* (*Nyssorhynchus*) *lutzii* Cruz 1901, the name *cruzii* was proposed by Dyar and Knab in 1908.

A single male from São Paulo, Brazil, previously mentioned, was examined, and the ventral lobes of the claspette were found to have a characteristic shape, and the mesosome had two long tubular leaflets, attached near the tip.

Peryassú (15) in "Os Culicideos do Brazil," on two unnumbered plates following the list of errata after page 407, gives a colored plate of the larva of "*Myzomyia lutzi* Theobald"

(=*cruzii* D. & K.), and a plate showing the details of the larva of this species. Figure E of this second plate shows the abdominal palmate tuft with distinctly lanceolate elements, although these are not mentioned in the formal description of the larva on pp. 328–329. In the discussion on p. 988 of Vol. 4 of "The Mosquitoes of North and Central America and the West Indies," by Howard, Dyar, and Knab, under *Anopheles neivai*, it is stated that Dr. Arturo Neiva of Rio de Janeiro, on a visit to the U. S. National Museum, pointed out that *neivai* H. D. & K. differs in the larva from the Brazilian species figured by Peryassú in the shape of the elements of the palmate hairs, which are ligulate and truncate in *neivai*, but lanceolate and sharply pointed in Peryassú's *Myzomyia lutzi* Theobald (=*cruzii* D. & K.). The type locality for *lutzi* (*cruzii*) is Rio de Janeiro, and Peryassú gives the locality for his material as Ilha Grande, Brazil.

The palmate hairs of the single larva from São Paulo, from which the male sent by Dr. Antunes was reared, have the single elements sharp-pointed. These hairs are present on abdominal segments 1 to 7.

As the male terminalia have never been correctly described, a description is given later in this paper, taken from a specimen from São Paulo, Brazil. As it is recognized that more than one species of the subgenus may occur in a given locality, it is proposed to restrict the name *cruzii* to the species which has leaflets on the mesosome, and ventral claspette lobes as here described and figured.

ANOPHELES NEIVAI H. D. & K.

This species, so far the only one of the subgenus to be found in Panama, was described from 2 females from Porto Bello Bay, Panama, in 1917 (12). It has been known under many names (see section on synonymy following), and has been confused with *cruzii*. The name which must be used for the Panama species, according to the rules of nomenclature, is *neivai* H. D. & K. as it is the first species to be described from Panama, where apparently it is the only species of the subgenus present. The number of pairs of palmate hairs and the character of the single elements of these hairs fixes the species, as they are absent on the first abdominal segment, and the single elements are "ligulate (strap-like) with straight truncate tips."

Dyar (9) states that the abdominal palmate hairs of the larvae of both *cruzii* and *bellator* also have the elements ligulate,

with straight truncate tips, failing to mention the larval differences between these species and *neivai*, which were plainly before him in the literature (12) (14), and upon which a separation of *neivai* from the other species of *Kerteszia* can easily be made.

In Panama, where the author has made many collections of *neivai* larvae during the past six years, the larvae are usually found in the water in the leaf-bases of a large terrestrial bromeliad locally known as "pita," a species of wild pineapple, *Ananas magdalenae* (André) Standl. The larvae are sometimes of a dull red color.

The male terminalia are somewhat variable in the number and width of the filaments of the dorsal lobe of the claspette. The species is certainly separable on terminalic characters from *A. cruzii* and *A. bellator*, as no mesosomal leaflets are present, and the form of the ventral claspette lobes is characteristic. Scales are not present on the abdominal segments, except the terminal one, of the adults.

The list of localities as given by Dyar in "The Mosquitoes of the Americas" needs revision, on the basis of our present knowledge. It is believed that the records under *A. cruzii* (p. 469) for Mexico, Costa Rica, Panama, Ecuador, and Peru are correct for *neivai*, while those for Brazil refer in part to *cruzii*, as discussed in this paper. Larvae of *neivai* are known from Panama and Mexico only, and as larvae or males are required for accurate determination of species, we may only infer its presence in the localities named above from our knowledge of faunal regions.

As the Central American fauna extends down the moist northwestern coast of South America, it is probable that *neivai*, being certainly present in Panama, is the species recorded from the coasts of Ecuador and Peru.

DESCRIPTIONS OF FEMALE ADULTS, MALE TERMINALIA, AND LARVAE OF THE KERTESZIA SPECIES

Anopheles (Kerteszia) bolivensis Theobald

(Pl. I, figs. 1 and 2)

The male and larva of this species have recently been described (5). The adult female resembles *neivai* and *cruzii* rather closely, but can be immediately recognized by the scaling of the abdomen; dark brown scales are present on the dorsum, and some white scales are present on the ventral surface. None of the other known species possess such abdominal scales. The palpi of *boliviensis* from Colombia are conspicuously white-banded, four such bands being present, while the palpi of *neivai* and *cruzii* are nearly all black. The markings of the

third vein of ***boliviensis*** apparently are variable, the majority of the specimens having this vein all black, and others having a small white basal spot, the middle broadly white, the remainder black, as in ***bellator***. The second vein has a broad patch of white scales at the fork. There are white fringe-spots at apices of all veins, a very broad one at tip of lower branch of fifth vein. The second, third, and fourth hind tarsal segments are less than half black basally, the remainder white. Fifth segment white with narrow black basal ring.

Anopheles (Kerteszia) cruzii Dyar & Knab.

(Pl. I, figs. 3 and 4)

The adult does not differ materially in thoracic markings from ***neivai***, ***bellator*** or ***homunculus***. The abdomen is without scales. The wing-markings show the white spots well-developed, and there are other small differences, so that the wing is herewith described.

WING:

The white markings enlarged, distinct. Costa with five large white spots, in addition to extreme base; black from basal white spot to humeral cross-vein, then a white spot shorter than preceding black area, followed by a black area four times the length of preceding white spot. Three large white spots, nearly evenly spaced, on outer half of costa, the most apical at junction of costa and 1st vein. A small black area beyond, and a white fringe-spot at tips of lower branch of 2nd and of 3rd vein. First vein white at base, a small black spot at humeral cross-vein, then a long white area followed by a black spot one-third its length. Then four white spots opposite corresponding white spots on costa, the most distal at junction of costa and first vein. Second vein black from base to fork, bases of each branch white, remainder dark; a few white scales opposite white spot at junction of costa and first vein. Third vein all white. Fourth vein dark-scaled, except a few lighter scales at cross-veins. Fifth vein alternating black, white, black, white, the latter white area involving fork and bases of the two branches; a few white scales on upper branch at cross-vein; remainder of each branch black. Sixth vein with small white spot basally, followed by an equal black spot; then white-scaled to middle, black beyond to tip.

Legs as in ***neivai***, the amount of white on the hind tarsi somewhat greater, the fifth segment white with a black basal ring.

MALE TERMINALIA:

Sidepiece rather short and stout, with scales and setae on outer aspect. A single long, slender, tapering, sinuate parabasal spine, with blunt tip, from a prominent tubercle from dorso-internal margin of sidepiece, at base. A pair of long, flattened, subequal accessory spines from a prominence slightly beyond middle of sidepiece. A single long, stout internal spine from a tubercle on ventro-internal aspect, between parabasal and accessory spines, slightly nearer the latter.

Clasper slightly longer than sidepiece; slender, curved, with moderate terminal spine; one or two fine setae on outer aspect near tip.

Mesosome with leaflets; shaft long, straight, hardly curved dorsally towards anal lobe, with slightly enlarged tip; the base with a triangular emargination ventrally. Leaflets stout, tubular (possibly trough-shaped?), pointed, about one-quarter the length of the mesosome; attached to ventral margin just below tip, and directed downwards and backwards (basad and ventrad) nearly at right angles to shaft of mesosome. Basal plates moderate, quadrangular, with upturned margins.

Claspette lobes. Dorsal lobe consisting of a low prominence, from which arise two groups of sinuate filaments, narrow and straight at base, acutely angled before middle, then greatly widened, curving over the ventral lobe, then gently recurving to tapering sharp tips. Ventral lobe very hairy, the base flattened, long, with a narrow sclerotized supporting strip on the internal face; internal margin straight. The expanded apex longer than broad, rounded, the inner margin with an area of very dense, radiating hairs; the outer apical margin somewhat serrate, incurving, the lateral basal margin produced, thin, rounded, and less hairy.

LARVA

HEAD:

Anterior internal clypeal hairs long, slender, usually simple; sometimes frayed at tip.

Anterior external clypeal hairs stout, about two-thirds length of inner clypeals; shaft somewhat frayed; set very close to inner clypeals.

Posterior clypeal hairs very long, nearly twice as long as the external clypeals; set well behind and somewhat external to the external clypeals. Shaft somewhat frayed near tip.

Subantennal hair long, much branched beyond middle.

Frontal hairs. Inner frontals long, somewhat frayed beyond middle; well separated. Middle frontals about two-thirds length of the inner, more slender, simple. Outer frontals nearly as long as the inner pair, stout, shaft somewhat frayed near tip. Set near edge of occipital suture.

Inner occipital hairs long, very slender, simple, tips exceeding bases of inner frontals; set well inside suture.

Outer occipital hairs long, very slender, simple, set close to edge of suture.

Antenna sparsely spined towards tip. Tuft a simple hair, one-third length of shaft; set near base on dorso-lateral aspect of shaft.

Sabres very long, pointed, infuscated; cone moderate; finger short.

Terminal hair simple, slightly exceeding sabres.

THORAX:

Dorsal submedian prothoracic hair-group with inner hair weak, with few lateral branches from slender shaft; set well apart from middle hair; middle hair stronger and longer, with many fine lateral branches; outer hair short, simple.

Large mesothoracic dorsal hair No. 1 very long, slender, finely feathered, the base somewhat thickened.

Small dorso-lateral hair short, with one or two branches near base. Metathoracic palmate hair absent.

Prothoracic pleural hair-group with one of the anterior pair very long, as long as hair No. 8 lying next to it, finely feathered; the other anterior hairs bifid, not laterally branched. Posterior ventral hair long, one-half length of ventral hair; usually split into two equal branches beyond middle. Spur very small.

Mesothoracic pleural hair-group with two long anterior hairs with few fine lateral branches. Posterior ventral hair short, about one-third length of the shorter anterior hair; bifid or trifid beyond middle. Posterior dorsal hair microscopic.

ABDOMEN:

Palmate hairs present on abdominal segments 1 to 7; those on 1 and 7 smaller than rest. The base from which the elements arise is long, conical, the elements arising from the free margins; single elements flattened, slender, with sharp-pointed tips.

Lateral hairs on abdominal segments 1 and 2 double, long, strong, much feathered. On abdominal segment 3 single, long, slender, slightly feathered; on segments 4, 5, and 6 single, long, slender, slightly feathered. Lateral long branched hair also on 7th abdominal segment. Hair No. 3 on abdominal segment 4 very long, strong, simple. Hair No. 2 on 5th segment long, strong, simple.

Respiratory apparatus proportionately rather smaller than in most Anopheline species.

Postspiracular hair simple.

Pecten with about 20 long, subequal, densely spaced teeth, coarsely fringed almost to tip.

Anal segment with posterior hair long, simple; dorso-lateral margin fringed with many fine spines.

Anopheles (Kerteszia) bellator Dyar & Knab.

(Pl. III, figs. 11 and 12)

The adult female resembles *neivai* and *cruzii* closely. The anterior edge of the wing generally appears somewhat darker than the posterior part, because of denser scaling. The costa has five white spots; a large white fringe-spot involves the tip of the lower branch of the second vein and the tip of the third vein, and smaller fringe-spots are at the tips of the other veins. Third vein with small white basal spot, the middle broadly white, remainder black.

The legs are much blacker than in any of the other species. The first segment of hind tarsus with black basal ring; dorsally black beyond, ventrally white, to narrow white apical ring; second, third, and fourth segments basally four-fifths black, a narrow white ring on apical fifth; fifth segment all black.

Palpi shaggy, black, except for a few white scales at tip of penultimate and ultimate segments.

Abdomen without scales, except on the cerci.

MALE TERMINALIA:

Sidepiece rather short, conical, with scales and setae on outer aspect.

A single long, slender, tapering, sinuate parabasal spine, with blunt tip, from a prominent tubercle from dorso-internal margin of sidepiece, at base. A pair of long, flattened, subequal accessory spines from a prominence slightly beyond middle of sidepiece. A single long, stout internal spine from a tubercle, on ventro-internal aspect, midway between parabasal and accessory spines.

Clasper slightly longer than sidepiece; slender, curved, with moderate terminal spine; one or two fine setae on outer aspect near tip.

Mesosome with leaflets. Shaft slightly curved dorsally (towards anal lobe), long, incompletely tubular, with slightly enlarged tip; the base with a triangular emargination ventrally. Leaflets long, smooth, tubular, pointed, attached postero-laterally at about one-fifth distance from tip of mesosome to base. Basal plates quadrangular, with upturned margins.

Claspette lobes. Dorsal lobe consisting of a tubular column with rounded tip, from which arise two groups of flattened sinuate filaments, narrow and straight at base, acutely angled before middle, then greatly widened, curving over the ventral lobe, then gently recurving to tapering sharp tips. Ventral lobe very hairy, the base long, triangular in cross-section, with narrow sclerotized supporting strip on internal face; internal margin straight; the expanded apex with an area of dense, long, radiating hairs on internal margin; the outer portion of apex expanded, flattened, curved, hood-shaped, with upcurving sclerotized apical tip, the lateral margin produced, rounded.

LARVA

The larva has never been correctly described, so a description is here given, taken from larval skins from Trinidad, from which associated adults were obtained. The larva is close to that of *cruzii*, but the postspiracular hair is definitely branched.

HEAD:

Anterior internal clypeal hairs long, slender, usually simple; set rather far apart.

Anterior external clypeal hairs short, about one-half length of internal hairs, somewhat stouter than the internal clypeals; usually simple.

Posterior clypeal hairs long, extending slightly beyond middle of anterior internal clypeals; simple, set somewhat external to the external clypeals.

Subantennal hair long, extending to tip of antenna; shaft simple at base, much branched at tip.

Frontal hairs. Inner frontals long, simple; tips extending to tips of external clypeals; bases set well apart. Middle frontals simple, about one-half length of the inner pair; the bases set somewhat posterior to those of inner pair. Outer frontals simple, very long, nearly as long as the inner pair; set near edge of occipital suture.

Inner occipital hairs simple, rather long, the tips reaching bases of inner frontals; set well inside suture.

Outer occipital hairs about one-half length of the inner occipital; usually simple; set close to suture, slightly anterior to the inner occipitals.

Antenna. Shaft slightly spined towards tip. Tuft a simple hair, about one-half the length of the shaft; set very near the dorsal aspect of the shaft.

Sabres very long, infuscated, sharp-pointed. Cone short, about one-fourth length of the sabres. Finger short.

Terminal hair simple, about same length as sabres.

THORAX:

Dorsal submedian prothoracic hair-group with inner hair weak, with few lateral branches from slender shaft; set well apart from middle hair; middle hair stronger and longer, with many fine lateral branches; outer hair short, simple.

Large mesothoracic dorsal hair No. 1 very long, slender, finely feathered, the base somewhat thickened.

Small dorso-lateral hair very long, sometimes with one or two branches near base; set close to base of large dorsal hair.

Prothoracic pleural hair-group with one of the anterior pair very long, as long as hair No. 8 lying next to it, finely feathered; the other anterior hair about two-thirds its length; much more coarsely feathered. Posterior ventral hair nearly as long as the anterior dorsal, simple. Posterior dorsal hair about one-half length of the ventral; simple, slender. Spur very short.

Mesothoracic pleural hair-group with one very long anterior hair, finely feathered; the other long, about two-thirds its length; much more coarsely feathered. Posterior ventral hair about one-half length of the shorter anterior hair, sometimes frayed near tip. Shaft slender, smooth. Posterior dorsal hair microscopic. Spur very short.

Metathoracic pleural hair-group with one hair very long, minutely feathered; the other hair about one-half its length, more coarsely feathered. Posterior ventral hair about one-half length of shorter hair, smooth, slender, with three or four terminal branches. Posterior dorsal hair microscopic. Metathoracic palmate tufts absent.

ABDOMEN:

Palmate hairs present on abdominal segments 1 to 7. Hairs very small; those on segments 1 and 7 smaller than the rest. The base from which the elements arise long, conical; the elements arising from the free margin; single elements flattened, lanceolate, with sharp-pointed tips.

Lateral hairs on abdominal segments 1 and 2 double, long, strong, much feathered; on abdominal segment 3 single, long, slender, slightly feathered; on segments 4, 5, and 6 single, long, slender, slightly feathered. Lateral long branched hair also on 7th abdominal segment. Hair No. 3 on abdominal segment 4 very long, strong, simple. Hair No. 2 on 5th abdominal segment long, strong, simple.

Respiratory apparatus proportionately rather smaller than in most Anopheline species.

Postspiracular hair apparently always branched.

Pecten with about 20 long, subequal, densely spaced teeth, fringed only on base.

Anal segment with lateral hair long, simple; dorso-lateral margin fringed with many long dense spines.

Anopheles (Kerteszia) neivai Howard, Dyar & Knab.
(Pl. II, figs. 5 to 8)

The adult female resembles *cruzii* and *homunculus* closely. The wing-pattern, shown in the photomicrograph accompanying this article, is characteristic of the subgenus as a whole. Individual specimens vary in the extent and distinctness of the wing-markings; in all specimens examined, however, the third vein had a small white spot at base, the remainder black. The hind tarsi have the first segment with a narrow basal white ring, followed by a wider black ring. Beyond, the segment is narrowly black above, broadly white below, to an indistinct black ring, followed by a broader white apical ring. Second, third, and fourth segments with base black, apical two-thirds of segments white; fifth segment with very narrow basal black ring, remainder white. The abdomen is clothed with long yellowish-brown hairs; scales are absent, except on the cerci. Palpi shaggy, dark brown, with a few white scales at extreme tip.

MALE TERMINALIA:

Sidepiece, clasper, anal lobe, and ninth sternite as in the other *Kerteszia* species.

Mesosome without leaflets. Shaft slightly curved dorsally (towards anal lobe), moderate, incompletely tubular, the tip slightly enlarged; the base with a triangular emargination ventrally. Basal plates moderate, quadrangular, with upturned margins.

Claspette lobes: Dorsal lobe a tubular column with rounded tip, from which arise two groups of flattened, sinuate filaments, widened and angled before middle, with long tapering tips. Ventral lobe as in accompanying photomicrograph; broad, somewhat triangular, the inner margin straight, somewhat thickened; the free margin thin, somewhat rounded, and clothed with dense long curving setae.

LARVA

As in *cruzii* and *homunculus*, except for the absence of palmate hairs on abdominal segment 1, and the form of the individual elements, which are ligulate (strap-like), with truncate (not sharp-pointed) tips. The postspiracular hair is simple.

Anopheles (Kerteszia) homunculus, n. sp.
(Pl. III, figs. 9 and 10)

During the course of the same survey mentioned previously in connection with *A. boliviensis*, an attempt was made to obtain the larvae of this species. Several *Kerteszia* larvae were collected from bromeliads, and adults reared from them, the cast larval skins being preserved. One male and two females were obtained, all from the same bromeliad. On dissecting and mounting the male terminalia, the mesosome was found to have two delicate tubular leaflets, attached well down on the sides.

The ventral claspette lobes had the form shown in the accompanying photomicrograph. The mesosomal leaflets in *homunculus* are much more slender than in either *cruzii* or *bellator*, and are attached well down from the tip of the mesosome. The appearance of the mesosome with its somewhat enlarged tip and dependent leaflets, suggests the appearance of a manikin, hence the descriptive name. The ventral claspette lobes differ in form from those of *cruzii* and *bellator*, and are as in *anoplus*, n. sp., but the mesosome in this latter species has no leaflets.

ADULT FEMALE

A small, delicate, grayish mosquito, with broadly white-banded hindlegs. Proboscis moderate, black. Palpi clothed with dense black outstanding scales, especially near the base; a few white scales at apex of penultimate segment, and at extreme tip of ultimate segment. Occiput with black scales, with a median line of triangular truncate scales mixed with obovate scales; these extend forward over the vertex as well. Vertex with a tuft of long white setae projecting forward over the clypeus.

Thorax with mesonotum gray, clothed with short gray setae, mixed with longer, stouter, black setae. Anterior prominence with a patch of white scales and setae; anterior edge of fossa outlined by a line of white scales. Disk of mesonotum with two bare black longitudinal lines on each side, making four longitudinal black stripes. A narrow, median, dorsal black line between the two inner lines. The inner lines extend only three-quarters of the distance towards the scutellum; their sides are parallel. The outer lines extend to the scutellum, widening beyond the middle, and narrowing towards their posterior ends. The anterior fossa is outlined by a gray line in the integument.

Pleura. Two parallel horizontal light lines across the pleura, the uppermost beginning posteriorly as a line of white scales slightly above middle of sternopleuron, continued as a grayish line in the integument of the mesanepisternum and the posterior pronotum, to the prothoracic lobes; the lower line, beginning posteriorly as a grayish line in the integument of the lower mesepimeral margin, extends anteriorly across the sternopleuron to the propleuron. Mid-mesepimeral setae absent; upper mesepimeral setae replaced by a small patch of white scales; upper sternopleural setae present; prothoracic and propleural setae present; prealar setae present.

Abdomen. Blackish, with many long brown hairs; a few lighter hairs on terminal segments. Scales absent, except on cerci.

Legs. Forelegs with femur somewhat swollen at base. A narrow basal black band, followed by a wider white band; the remainder irregularly streaked with black and white. Tibia with four longitudinal alternating stripes of black and white. Tarsus with first segment dorsally with basal white spot, ventrally black, followed by a black ring;

then a white spot on each side, followed by a black ring; apex with a white dorsal spot. Ventral surface all dark. Second segment with ventral surface all dark; a narrow basal black ring, followed by a dorsal white streak to tip. Third segment similarly marked. Fourth and fifth segments all dark.

Mid-Legs. Femur with very narrow white basal ring, followed by a narrow incomplete black ring. Dorsal and ventral surfaces black. Sides with narrow longitudinal white stripe, interrupted by black, then a long white streak and a black band at apex. Tibia with narrow basal white ring, followed by a narrow black ring. Dorsal and ventral surfaces black; sides white; apex of segment with narrow black ring. Tarsi with first segment with very narrow basal white ring. Ventral surface black, dorsal surface white; a narrow apical white ring. Second segment with narrow black basal ring; ventral surface black, dorsal surface white beyond basal ring, to apex. Third, fourth, and fifth segments all dark.

Hind-Legs. Hind-femur with narrow basal white ring, followed by a black ring. Extreme tip dark. Dorsal surface black. Hind-tibia with narrow basal white ring; dorsal surface all dark beyond, to apex. Ventral surface white, an incomplete black ring beyond basal white ring. A conspicuous triangular white spot on outer lateral surface, before tip. First hind-tarsal segment with a very narrow white ring, followed by a broader black ring, which is followed by a white ring. Dorsal surface beyond, dark, to a conspicuous narrow apical white ring. Ventral surface white beyond first black ring, the white tapering towards apex, where it merges with the narrow apical white ring. Second segment basally slightly less than half black, apically white. Third segment basally one-third black, apically white. Fifth segment basally about one-third black, apically white.

Wing. Costa with extreme base white, followed by black to humeral cross-vein; a small white spot just beyond cross-vein, followed by a long dark area; three white spots nearly evenly spaced on outer half of costa, the most apical and largest at junction of costa and first vein. First vein with a few white scales before humeral cross-vein; a small black spot at cross-vein; white spots opposite each succeeding costal white spot; tip white at junction with costa. Second vein with a few white scales on upper branch before tip; remainder of vein and lower branch dark. Third vein with small white basal spot, and another white spot ending before middle of vein; remainder black. Fourth vein with small white spot at tip of lower branch. Fifth vein with four equal alternating areas of black and white from base; upper branch with small white spot at cross-vein between veins 4 and 5; remainder of both branches black. Sixth vein all dark. White fringe-spots at tip of lower branch of second vein, and at tips of lower branch of fourth, and upper branch of fifth veins.

MALE TERMINALIA:

Sidepiece rather short and stout, with scales and setae on outer aspect. A single long, slender, tapering, sinuate parabasal spine, with blunt tip, from a prominent tubercle from dorso-internal margin of

sidepiece, at base. A pair of long, flattened, subequal accessory spines from a prominence slightly beyond middle of sidepiece. A single long, stout internal spine from a tubercle on ventro-internal aspect, between parabasal and accessory spines, slightly nearer the latter.

Clasper slightly longer than sidepiece; slender, curved, with moderate terminal spine; one or two fine setae on outer aspect near tip.

Mesosome with leaflets. Shaft slightly curved dorsally (towards anal lobe), long, incompletely tubular, with slightly enlarged tip; the base with triangular emargination ventrally. Leaflets moderate, delicate, smooth, tubular, pointed, attached laterally at about one-fifth distance from tip of mesosome to base. Basal plates moderate, quadrangular, with upturned margins.

Claspette lobes. Dorsal lobe consisting of a tubular column with rounded tip, from which arise two groups of narrow, flattened, sinuate filaments, straight at base, acutely angled before middle, curving over the ventral lobe, then gently recurving to tapering sharp tips. The filaments arise in two groups of about three each, from tip of column. One or two of the dorsal group may be widened at the curve. Ventral lobe very hairy, the ventral aspect with a narrow, sclerotized supporting plate, on the inner surface; the triangularly expanded apex bearing on its inner margin dense radiating hairs, the curved apical margin with long curved hairs, the tip with dorsal margin produced and curved, somewhat beaked, with a median stiffening; the lateral basal angle thin, triangularly produced, nearly bare.

Ninth tergites without processes, membranous centrally, the lateral portions minutely pilose. Paraprocts not well developed.

Anal lobe moderate, conical, pilose.

Ninth sternites with slight median suture, somewhat sclerotized, the upper margin with two lateral semicircular emarginations, forming a median and two lateral apical sclerotized projections.

LARVA

HEAD:

Anterior internal clypeal hairs long, slender, usually simple, set rather far apart.

Anterior external clypeal hairs short, about one-half length of the internal clypeals, somewhat stouter.

Posterior clypeal hairs long, extending beyond the tip of the external clypeals, set slightly external to external clypeals.

Subantennal hair long, shaft simple, usually slightly branched at tip.

Frontal hairs: Inner frontals long, simple; tips extending to tips of external clypeals; insertions somewhat anterior to those of middle frontals, well separated. Middle frontals nearly as long as inner frontals, slender, simple, set well away from inner frontals. Outer frontals long, slender, usually simple, sometimes slightly frayed at tip; set near edge of occipital suture.

Inner occipital hairs very slender, simple, about as long as inner occipital hairs; set close to suture, slightly anterior to the inner occipitals.

Antenna minutely spined towards tip. Tuft a simple hair on dorso-lateral aspect, about one-third the length of the shaft; set very near the base.

Sabres long; cone long, about one-half length of sabres. Finger short.

Terminal hair scarcely exceeding sabres, very slender, simple.

THORAX:

Dorsal submedian prothoracic hair-group with inner hair weak, with few lateral branches from slender shaft. Middle hair stronger and longer, with many fine lateral branches. Outer hair long, simple.

Large mesothoracic dorsal hair No. 1 very long, slender, finely feathered, the base somewhat thickened.

Small dorso-lateral hair very long, slender, with a few lateral branches arising at base; set close to base of large dorsal hair.

Prothoracic pleural hair-group with one of the dorsal hairs very long, as long as the hair No. 8 lying next to it, finely feathered; the other dorsal hair shorter, more heavily feathered. The posterior ventral hair long, very slender, simple. The posterior dorsal hair unusually long, slender, simple, about two-thirds length of the ventral hair.

Mesothoracic pleural hair-group with two long anterior dorsal hairs, finely feathered. Posterior dorsal hair short, about four-branched just before middle. Posterior ventral microscopic.

Metathoracic palmate tufts absent.

ABDOMEN:

Palmate hairs present on segments 1 to 7; those on segments 1 and 7 smaller than the others. The base from which the elements arise is long, conical; the single elements rather short, flattened, lanceolate, sharp-pointed; each hair with about 25 elements.

Lateral hairs on abdominal segments 1 and 2 double, long, strong, much feathered. On abdominal segment 3 single, long, slender, slightly feathered; on segments 4, 5, and 6 single, long, slender, slightly feathered. Hair No. 2 on segment 4 very long and strong.

Respiratory apparatus proportionately rather smaller than in most Anopheline species.

Postspiracular hair long, simple.

Pecten with about 21 teeth, alternately long and short, particularly the central teeth; teeth moderately fringed at base only.

Anal segment with posterior hair simple; the posterior dorsal margin fringed with many fine setae.

TYPE MATERIAL: Three ♀ ♀, one ♂, the male terminalia in a balsam mount. Associated larval skins preserved. Material deposited in U. S. National Museum, Washington, D. C.

TYPE LOCALITY: Restrepo, Colombia, August, 1935. W. H. W. Komp, collector.

Anopheles (Kerteszia) anoplus, n. sp.
Pl. III, figs. 13 and 14)

Dr. E. Osorno M., who obtained the previously unknown larva and male of *A. boliviensis* in Restrepo, Colombia, and later described them with the author (5), also obtained a single male of another species, with associated larva, which he presented to the writer. This larva was found in a bromeliad, and was thought to be the same as that of *homunculus*. However, on examining the male terminalia, the mesosomal leaflets found in *homunculus* were not present in *anoplus*, although the form of the ventral lobes of the claspette is nearly the same. The larva is indistinguishable from that of *cruzii* (q. v.), and closely resembles that of *bellator* and *homunculus* also.

The characters of the male type are similar to those of *A. homunculus*. The only marked difference observed is in the markings of the third wing-vein.

MALE TERMINALIA:

As in *homunculus*, except for mesosome, which lacks leaflets.

Wing. Costa with extreme base white; a small black area before humeral cross-vein, followed by a white spot of equal length; then a long black area followed by a small white spot; three white spots nearly evenly spaced on outer half of costa, the most apical at junction of costa and 1st vein. First vein with base white to middle of first long dark costal area; white spots opposite each succeeding costal white spot; tip white at junction with costa. The 2nd vein with a few white scales on upper fork before tip, remainder of vein and lower branch dark scaled. 3rd vein white-scaled from base to outer fourth; then black to tip. 4th vein all dark. 5th vein with white spot beyond base; white scales at fork, extending along both branches; white scales on upper branch at cross-vein. 6th vein all dark. White fringe-spots at tip of both branches of 2nd vein, and at tip of 6th vein.

Legs. First hind tarsal segment with very narrow white ring followed by a broader black ring; then a white ring; middle of segment dorsally white, ventrally black; then a wide black ring followed by a narrow apical white ring. Second hind tarsal segment basally about two-thirds black, apically white. Third hind tarsal segment basally slightly less than half black, apically white. Fourth hind tarsal segment basally one-half black, apically white. Fifth hind tarsal segment basally about one-quarter black, apically white.

LARVA

As in *cruzii*, no distinguishing characters being noted.

Type, one male, the terminalia in a balsam mount; this material, together with associated larval skin, is deposited in

the U. S. National Museum. Type locality, Restrepo, Intendencia of Meta, Colombia; collector E. Osorno M., December, 1936.

It is believed that *anoplus* is the species found by the Bonnes (25) in Surinam (Dutch Guiana), which they call *bellator*, as their figure shows the mesosome without leaflets, and the palmate hairs of the larva with sharp-pointed tips. Dr. Stone of the U. S. National Museum kindly reported that there is a single mounted male terminalia in the collection, from Surinam, apparently without leaflets. In the Surinam specimens the markings of the third vein differ from those of the type of *anoplus*, as in the Bonnes' material this vein is said to have only a small white spot at the base, the rest black. Davis' species (26) may well be *anoplus*, but he gives no description of the male terminalia or larva, nor is the amount of white on the third wing-vein or on the segments of the hind tarsi specified.

Anopheles (Kerteszia) bambusicolus, n. sp.

Dr. Jorge Boshell, of the Staff of the Yellow Fever Service of the Rockefeller Foundation, working with the author in Colombia in 1935, obtained larvae of a *Kerteszia* species from a hitherto unreported and peculiar habitat, the unbroken joints of large bamboo, containing a small amount of water, the only entrance to which was through small worm-holes (21). The larvae were quite large for a *Kerteszia*, and were very dark in color. About a dozen larvae were obtained, but all died except three, from which three female adults emerged. These were recognized as new to science, and are herewith described, together with the larva. The species may be recognized by the dark costa of the wing, only one white spot being present; the fifth segment of the hind tarsus is pure white, a character also peculiar to the species.

ADULT FEMALE

A medium-sized, blackish mosquito, with small wing-spots, and conspicuously white-banded hind legs. Proboscis moderate, black. Palpi shaggy, clothed with many outstanding black scales, especially near the base; a few white scales at apex of penultimate segment; last segment wholly black. Occiput black, with erect black scales; a median line of triangular white scales with truncate tips extending forward over the vertex. Vertex with a tuft of long white setae projecting forward over the clypeus.

Thorax with mesonotum gray, clothed with short gray setae, mixed with longer, stouter black setae. Anterior prominence with a

patch of white setae and scales. Anterior edge of fossa outlined by a line of white scales. Disk of mesosotum with two bare black longitudinal lines on each side, making four longitudinal black stripes. A narrow median dorsal black line between the two inner lines. The inner lines extend only three-quarters of the distance towards the scutellum; their sides are parallel. The outer lines extend to the scutellum, widening out beyond the middle, and narrowing towards their posterior ends. The anterior fossa is outlined by a gray line in the integument.

Pleura very dark, crossed by two horizontal light lines, the upper beginning posteriorly as a grayish line below the upper mesepimeral setae, joining a line of white scales slightly above middle of sternopleuron, and extending anteriorly as a grayish line in the integument of the posterior pronotum to the prothoracic lobes, which have a few light scales; the lower line, beginning posteriorly as a grayish line in the integument of the lower mesepimeral margin, extends anteriorly across the sternopleuron to the base of the fore coxa. Mid-mesepimeral setae absent; upper mesepimeral setae very long, white, in a patch of white scales; upper sternopleural setae present; prothoracic and propleural setae present; prealar setae present.

Abdomen blackish, with many long brown hairs; scales absent, except on cerci.

Legs. Forelegs with femur somewhat swollen at base. A narrow basal white band, followed by a narrow black band; the remainder irregularly streaked with black and white. Fore-tibia with four longitudinal alternating stripes of black and white. Fore-tarsus with first segment with ventral surface all dark; dorsal surface with basal white spot, followed by a black ring; then a long white streak on each side, enclosing a black dorsal area, and joining a conspicuous white area at apex. Second segment with ventral surface all black; a narrow black basal ring; dorsal surface conspicuously white to tip. Third and fourth segments similarly marked; fifth segment all dark.

Mid-Legs. Mid-femur with extreme base white, followed ventrally by an incomplete narrow black ring; dorsal and ventral surfaces black; sides white. Mid-tibia with dorsal and ventral surfaces white, interrupted on dorsal surface before apex by black, followed by an apical white spot; sides black. Mid-tarsus with first and second segments with a very narrow basal black ring; dorsal surface white beyond to tip; ventral surface all black. Third and fourth segments all black, fifth segment black at base, very narrowly white at tip.

Hind-Legs. Hind-femur very narrowly white at base, followed by a narrow black ring. Dorsal and ventral surfaces black, sides white. Hind-tibia with dorsal and ventral surface black, sides white, widening conspicuously on outer surface just before tip; an incomplete narrow black ring before tip. Hind-tarsus with first segment ventrally all black; a wide basal black ring, dorsally interrupted by a small white spot. Dorsal surface white beyond basal black ring, to two-thirds distance to apex, then a wide black ring interrupted dorsally by a conspicuous white spot at tip. Second segment with narrow black ring at base, the black extending ventrally towards tip, underlying the white,

which forms a narrow white apical ring, and extends dorsally towards the base, overlying the black, the two colors dovetailing above and below. The general effect is that the segment is basally black-banded, apically white-banded, the portion between the bands being white dorsally, black ventrally. Third segment basally one-fourth black, apically white. Fourth segment basally one-half black, apically white. Fifth segment all white.

Wing. Very dark, the wing-spots much reduced; scales very narrow. Costal margin all dark from base to junction of costa with first vein, where there is a conspicuous white spot. First vein white at base, a small black spot at humeral cross-vein, followed by white, a black area and a smaller white spot. Then a black area followed by a white spot opposite the white spot on fork of 5th vein; then a dark area, followed by a conspicuous white spot opposite fork of second vein. Then a dark area followed by a white spot, coalescing with costal white spot at the junction of costa and 1st vein. Second vein all dark. Third vein with small white spot at base, remainder dark. Fourth vein all dark except extreme tip of lower branch, which is white. Fifth vein dark, with white spot beyond humeral cross-vein, at fork on both branches, and at cross-vein between upper branch and 3rd vein; extreme tip of lower fork white. Sixth vein all dark. Wing-fringe with usual apical white spot at tips of lower branch of second vein and third vein absent; a conspicuous white fringe-spot at tip of lower branch of fourth vein; another at tip of upper branch of fifth vein.

LARVA

HEAD:

Head capsule heavily sclerotized, very dark.

Anterior internal clypeal hairs short, slender, simple.

Anterior external clypeal hairs about one-half length of inner hairs; slender, simple.

Posterior clypeal hairs moderate, about as long as the anterior external clypeals; set well behind and slightly exterior to these.

Subantennal hair extending to tip of antenna; long, slender, simple.

Frontal hairs. Inner frontals short, not extending to insertion of posterior clypeals; well separated, smooth, simple. Middle frontals about one-half length of the inner, simple, set close to the inner frontals. Outer frontals as long as inner frontals, simple, set near edge of occipital suture.

Inner occipital hairs short, not extending to insertion of middle frontals, simple.

Outer occipital hairs very small, about one-half length of the inner occipital hairs; simple, set close to suture.

Antenna. Shaft nearly smooth; tip very dark, lighter towards base; a few very minute spines towards tip. Tuft a simple hair, about one-quarter length of shaft, set very near the base of the lateral aspect of the shaft.

Sabres much reduced, very short; cone about one-quarter length of sabres. Finger very short.

Terminal hair simple, hardly longer than sabres.

THORAX:

Integument very dark, opaque.

Dorsal submedian prothoracic hair-group with inner hair moderate, the central branch very long, about one-half length of the middle hair. Lateral branches few, slender. Middle hair stronger and longer, about twice the length of the inner hair, with many fine, long lateral branches. Outer hair long, simple.

Large mesothoracic dorsal hair No. 1 very long, slender, finely feathered, the base somewhat thickened.

Small dorso-lateral hair very long, usually simple, sometimes frayed, set close to base of large dorsal hair.

Prothoracic pleural hair-group with one of the anterior pair very long, as long as hair No. 8 lying next to it; nearly smooth, with a few minute branches on shaft. The other anterior hair about three-quarters length of the longest hair, smooth, simple. Posterior ventral hair not quite so long, simple. Posterior dorsal hair very short, about one-sixth the length of the ventral hair, usually branched at middle. Spur very short.

Mesothoracic pleural hair-group with two long anterior hairs; the longer hair thicker, feathered; the other hair about three-quarters its length, apparently simple. Posterior ventral hair very short, simple.

Metathoracic pleural hair-group with anterior dorsal hair long, finely feathered, much thicker than the anterior ventral, which is apparently simple, very slender, and two-thirds the length of the anterior dorsal. Posterior dorsal hair long, very slender, simple. Posterior ventral hair microscopic. Metathoracic palmate tufts absent.

ABDOMEN: Integument very dark.

Palmate hairs present on abdominal segments 1 to 7; those on segments 1 and 7 much smaller than the others. The base from which the elements arise is notably short; single elements very long, lanceolate, sharp-pointed, much like those of *A. albimanus*. Each palmate hair with about 20 leaflets.

Lateral hairs on abdominal segment 1 and 2 double, long, strong, finely feathered; on abdominal segment 3 single, long, slender, slightly feathered; on segment 4, 5, and 6 single, long, slender, slightly feathered. Hair No. 2 on 4th abdominal segment very long and strong, about three-fourths the length of the corresponding lateral hair. Hair No. 4 on 5th abdominal segment notably stout, but not so long.

Respiratory apparatus proportionately rather smaller than in most Anopheline species.

Postspiracular hair very short, simple.

Pecten with about 18 very long, slender, subequal teeth, becoming somewhat longer ventrally. The dorsal teeth fringed only at base, the ventral teeth nearly to tip.

Anal segment with lateral hair moderate, simple; the posterior dorsal margin usually fringed with a few very coarse spines.

TYPE MATERIAL: Three ♀ ♀, with associated larval skins, deposited in U. S. National Museum, Washington, D. C.

TYPE LOCALITY: La Union, Intendencia of Meta, Colombia, September, 1935, Dr. Jorge Boshell, collector.

The following keys will definitely separate the known males; the adult females of *boliviensis*, *bellator*, and *bambusicolus* are easily separable, but *cruzii* and *anoplus* are very similar, as are *neivai* and *homunculus*. The larvae of *neivai* and *bambusicolus* are easily identified, *boliviensis* less easily so, but no good characters to separate the other species have been found.

KEY TO ADULT FEMALES OF KERTESZIA

1. Abdomen with black scales on apices of tergites, except the first; second to fifth sternites with median white scales ..... **boliviensis**
   Abdomen without scales, except on cerci 2
2. Hind tarsi with segment 5 all dark; segments 3, 4, and 5 narrowly white at apices ..... **bellator**
   Hind tarsi with segment 5 partly or all white; segments 3, 4, and 5 broadly white at apices 3
3. Segment 5 of hind tarsi all white; wing with white markings reduced; only one white spot on costa, near tip ..... **bambusicolus**
   Segment 5 of hind tarsus with base black, apex white; wing with more than one white spot on costa 4
4. Third wing-vein nearly all white ..... **cruzii, anoplus**
   Third wing-vein with white spot at base 5
5. Third wing-vein with white spot at base only ..... **neivai**
   Third wing-vein with white spot at base, another long white area before middle, rest dark ..... **homunculus**

KEY TO MALE TERMINALIA OF KERTESZIA

1. Mesosome with two leaflets 2
   Mesosome without leaflets 4
2. Mesosome with leaflets attached near tip; ventral claspette lobes with distal portion rounded, not notably upturned and pointed ..... **cruzii**
   Mesosome with leaflets attached somewhat below tip 3
3. Mesosomal leaflets stout, ventrally directed, attached slightly below tip; ventral claspette lobes with distal portion upcurved, pointed ..... **bellator**
   Mesosomal leaflets delicate, apparently not ventrally directed, set well below tip; ventral claspette lobes with distal portion widened, flattened, with hood-like triangular apex ..... **homunculus**
4. Ventral claspette lobes widened and truncate at apex; apical margin not thickened, fringed with very long hairs ..... **neivai**
   Ventral claspette lobes not widened and truncate at apex; distal margin with hood-like triangular apex ..... **anoplus**
   Ventral claspette lobes rounded at tip, the distal margin not notably thickened, upturned, or pointed ..... **boliviensis**

KEY TO LARVAE OF KERTESZIA

1. Palmate hairs absent on first abdominal segment 2
   Palmate hairs present on first abdominal segment 3
2. Anterior external clypeal hairs short, much thickened, fusiform; elements of palmate hairs sharp-pointed ..... **boliviensis**
   Anterior external clypeal hairs longer, slender, not fusiform; elements of palmate hairs truncate and blunt at tips ..... **neivai**
3. Head-capsule and body-integument very dark; head-hairs all much reduced; subantennal hair simple; antennal sabres very short; palmate hairs large, with long lanceolate elements ..... **bambusicolus**
   Head-capsule and integument not heavily infuscated; head-hairs normal; subantennal hair branched at tip; antennal sabres long; palmate hairs small, the elements short, pointed 4
4. Postspiracular hair branched ..... **bellator**
   Postspiracular hair simple ..... **cruzii, homunculus, anoplus**

SYNONYMY

The synonymy of the earliest described species of the subgenus, *boliviensis*, *cruzii*, *bellator*, and *neivai*, has suffered many changes. It is impossible, within the limits of this paper, to quote full synonymies, but those species probably dealt with in the more important papers will be noted. The most important changes made necessary by the author's observations are the fixing of the name *neivai* for the common Panama species, and the restriction of the name *cruzii* to the Brazilian form in which the male possesses mesosomal leaflets.

Anopheles (Kerteszia) boliviensis Theobald, 1905

Anopheles boliviensis Theobald, Ann. Mus. Nat. Hung. III, 66, 1905.
Anopheles boliviensis Theobald, Mon. Culic, VI, 118, 1907.
Anopheles boliviensis Knab, Rept. First Exped. to S. Amer., 1913. Harvard Univ. Press, p. 216, 1915.
Anopheles boliviensis Knab, Ins. Ins. Mens., I, 17, 1913 (in part, *cruzii*).
Anopheles boliviensis Dyar & Knab, Ins. Ins. Mens., V, 40, 1917 (in part, *cruzii*).
Anopheles boliviensis Dyar, Ins. Ins. Mens., VI, 148, 1918.
Anopheles boliviensis Christophers, Ind. Med. Res. Mem. III, 42, 1924.
Anopheles boliviensis Bonne & Bonne-Wepster, Mosquitoes of Surinam, 533, 1925.
Anopheles boliviensis Dyar, The Mosquitoes of the Americas, 467, 1928.
Anopheles boliviensis Edwards, Diptera, Fam. Culicidae, Genera Insectorum, Fascicle 194, 46, 1932.
Anopheles boliviensis Komp, Proc. Ent. Soc. Wash. XXXVIII, 57, 1936.
Anopheles boliviensis Komp & Osorno, Ann. Ent. Soc. Amer., XXIX, 415, 1936.

Anopheles (Kerteszia) cruzii Dyar & Knab, 1908

Anopheles lutzi Theobald (not Cruz), Mon. Culic, I, 177, 1901.
Anopheles lutzii Lutz (not Cruz), Centralbl. Bact., etc., Abt. I, 283, 1903.
Myzomyia lutzii Lutz (not Cruz), Journ. Trop. Med., VI, 112, 1903.
Myzomyia lutzii Peryassú, Os Culicideos do Brasil, 78, 1908.
Anopheles cruzii Dyar & Knab, Proc. U. S. Nat. Mus. XXXV, 53, 1908.
Anopheles cruzii Dyar & Knab, Ins. Ins. Mens., VI, 141, 1918.
Anopheles cruzii Dyar & Knab, Ins. Ins. Mens., VI, 146, 1918.
Anopheles bellator var. *cruzii* Christophers, Ind. Med. Res. Mem. III, 42, 1924.
Anopheles cruzii Dyar, Ins. Ins., Mens., XIII, 26, 1925 (in part).
Anopheles cruzii Dyar, Ins. Ins. Mens., XIII, 193, 1925 (in part, *neivai*).
Anopheles cruzii Root, Am. Journ. Hyg., Mon. Sec. No. 5, 52, 1926.
Anopheles cruzii Dyar, The Mosquitoes of the Americas, 468, 1928 (in part).
Anopheles cruzii Edwards, Diptera, Fam. Culic., Genera Insectorum, Fasc. 194, 46, 1932.

Anopheles (Kerteszia) bellator Dyar & Knab, 1906

Anopheles bellator Dyar & Knab, Proc. Biol. Soc. Wash., XIX, 160, 1906.
Anopheles bellator Theobald, Mon. Culic., V, 86, 1910.
Anopheles bellator Howard, Dyar & Knab, Mosq. No. and Cent. Amer. and W. I., 985, 1917.
Anopheles bellator Dyar & Knab, Ins. Ins. Mens., V, 40, 1917.
Anopheles bellator Dyar, Ins. Ins. Mens., VI, 145, 1918.
Anopheles bellator Root, Am. Journ. Hyg., III, 278, 1923.
Anopheles bellator Dyar, Ins. Ins. Mens., XI, 72, 1923 (in part).
Anopheles bellator Christophers, Ind. Med. Res. Mem., III, 42, 1924.
Anopheles bellator Dyar, Ins. Ins. Mens., XIII, 27, 1925.
Anopheles bellator Dyar, The Mosquitoes of the Americas, 469, 1928.
Anopheles bellator Edwards, Diptera, Fam. Culic, Genera Insectorum, Fasc. 194, 1932 (in part).

Anopheles (Kerteszia) neivai Howard, Dyar & Knab, 1917

Anopheles neivai Howard, Dyar & Knab, Mosq. North and Cent. Amer. and W. I., IV, 987, 1917.
Anopheles hylephilus Dyar & Knab, Ins. Ins. Mens., V, 38, 1917 (in part).
Anopheles neivai Dyar & Knab, Ins. Ins. Mens., V, 40, 1917.
Anopheles hylephilus Dyar & Knab, Ins. Ins. Mens., VI, 146, 1918 (in part).
Anopheles neivai Dyar & Knab, Ins. Ins. Mens., VI, 146, 1918.
Anopheles neivai Root, Am. Jour. Hyg., II, 391, 1922.
Anopheles bellator var. *neivai* Christophers, Ind. Med. Res. Mem. III, 42, 1924.
Anopheles bellator var. *hylephilus* Christophers, Ind. Med. Res. Mem., III, 42, 1924 (in part).
Anopheles neivai Edwards, Diptera, Fam. Culic., Genera Insectorum, Fasc. 194, 46, 1932.

Anopheles (Kerteszia) anoplus, n. sp.

?Anopheles bellator Bonne & Bonne-Wepster, Mosquitoes of Surinam, p. 504, 1925.
?Anopheles bellator Davis, Am. Journ. Hyg., VI, 119, 1925.

Anopheles (Kerteszia) bambusicolus, n. sp.

Anopheles bellator Komp, Proc. Ent. Soc. Wash., XXXVIII, 68, 1936.

This hitherto purely technical paper is closed by throwing a sop to that Cerberus, the "practical man," who is interested in the economic significance of the taxonomist's studies.

We know very little, comparatively, concerning the malaria-carrying powers of many Neotropical Anophelines. It may be that, as our knowledge increases, we shall find that slight differences in habitat, biting-habits, and life-history make considerable differences in the relative importance of species which are much alike in general appearance and biology. A knowledge of the exact species concerned in malaria transmission is of fundamental importance in its control. This fact has been abundantly confirmed by observations made in many parts of the world. The "practical men" who are in charge of anti-mosquito measures have been handicapped by lack of this knowledge, and have perforce called the mosquito they worked with by the name provided by the systematist. This name may or may not have applied to a single species. If two closely similar species were involved, confusion and loss ensued when control measures applicable to one were applied to the other species.

Hitherto the nomenclature of the *Kerteszia* group has been based on studies of scanty material, so much so that only 3 species have been previously recognized. Little account has been taken of the possibility that there may be species differences which involve differences in biology, and hence are of practical importance. It is hoped that this paper will help to clear up the problem of nomenclature in this group.

Several instances of malaria infection in species of the *Kerteszia* group are recorded in the literature. Root (27) reports the work of Galli-Valerio, who found one specimen with oöcysts; Davis (26), working in Brazil, reports the infection of a species which he calls *bellator*.

A striking commentary on the advance of our knowledge of the role of mosquitoes as vectors of disease, and the changes in view-point necessitated thereby, is furnished by the recent discovery of "jungle yellow fever" (28), which is carried by mosquitoes other than *Aedes aegypti*. A similar change in opinion regarding the hazards from one of the *Kerteszia* species is illustrated by the following quotations. Howard, Dyar & Knab (10) in 1917 state concerning the *Kerteszia* species in Trinidad, "We have received no specimens of *Anopheles bellator* (from Trinidad) since the original types. It is probably more widely spread, but, as it is not taken unless bred and occurs in such unusual situations, it is seldom collected."

A very different picture is given in the Administration Report of the Surgeon General for the Colony of Trinidad and Tobago for 1934 (29). A part of this report is given verbatim, with few omissions:

"It is especially interesting to note the change of behavior of this 'forest' anopheles and its effective methods of adaptation to the changed conditions which presented themselves when the forests in the Cumuto-Talparo-Tamana area gave way to the axe of the cocoa planter between about 1895 and 1905.

"Large tracts of forest were cut down and replaced by cocoa and its shade trees, the immortelle [*Erythrina* spp.].

"These trees grew rapidly under good soil conditions and with a favourable rainfall; but unfortunately these new conditions proved to be also particularly favourable to the growth of water holding bromeliads especially on the immortelle or shade trees, and to-day practically every such tree harbours malarial-carrying *Anopheles bellator*.

"As the cocoa estates developed, the human and stock (animal) population gradually increased but from the very outset Malaria proved to be a real scourge, and only a few estate houses and malarious villages now exist to show the uphill fight which has been waged by the cocoa planters.

"The Spleen rate of school children between 4–8 years of age at Four Roads-Tamana was found to be 66 per cent. and at Coryal Tamana 70 per cent. in 1934.

"During the months of May and June, 1934, following a report of the large prevalence of anopheles in the district, [Cumuto-Talparo-Tamana area] a special anopheles and topographical survey was made which disclosed a very surprising, interesting and disconcerting state of things: . . . towards evening between 4 and 8 p. m. large

numbers of *A. bellator* adults were found to be swarming in every house, and village in the district wherever they happened to adjoin a cocoa estate.

"In the forests also adults could always be seen to bite even during the daytime, but their numbers were conspicuously less here as well as in such houses as adjoined these forests. . . . They bite commonly between 4 and 8 p. m. on the main roads near cocoa cultivations, in the open yards and also inside the galleries and rooms of the houses and appear to feed equally on man or beast. In the early morning also as well as immediately after heavy showers of rain on cloudy days the labourers are freely attacked in the cocoa fields. . . ."

The author was able to verify these statements during a visit to Trinidad in the summer of 1936. It is fair to state, however, that the evidence is purely epidemiological on which Dr. Eric de Verteuil, who discovered the conditions outlined above, bases his conclusions as to the role of *bellator* as a vector of malaria. No dissections of wild-caught females have been made, nor have experimental infections been attempted. However, no other Anopheline occurs in sufficient numbers in the area to be considered a factor in transmission, and the epidemiological evidence, so far as it goes, is rather conclusive.

Dr. D. P. Curry, Assistant Chief Health Officer of the Panama Canal (30) reports being severely bitten by *Anopheles neivai* females, in the immediate vicinity of their breeding-places in "pita" plants, and in some locations on the Atlantic side of the Canal Zone the insects are a pest to the troops on duty at searchlight stations in the jungle, where the same plant is abundant. There are no records of dissections or experimental infections of this species in Panama, or elsewhere.

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EXPLANATION OF PLATES

Plate I

Figs. 1 and 2. *Anopheles* (*Kerteszia*) *bolivensis*, male. 1. Mesosome. 2. Claspette lobes.

Figs. 3 and 4. *Anopheles* (*Kerteszia*) *cruzii*, male. 3. Mesosome. 4. Claspette lobes.

Plate II

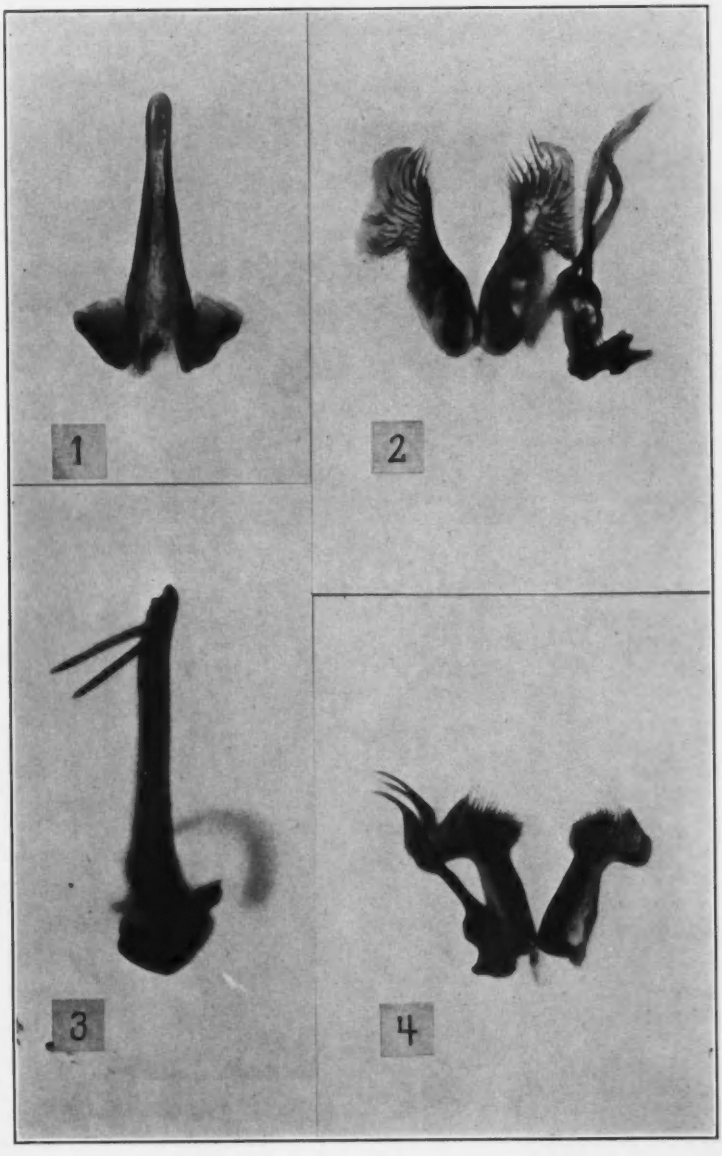
Figs. 5–8. *Anopheles* (*Kerteszia*) *neivai*, male. 5. Wing. 6. Ninth sternite. 7. Mesosome. 8. Claspette lobes.

Plate III

Figs. 9 and 10. *Anopheles* (*Kerteszia*) *homunculus*, male. 9. Mesosome. 10. Claspette lobes.

Figs. 11 and 12. *Anopheles* (*Kerteszia*) *bellator*, male. 11. Mesosome. 12. Claspette lobes.

Figs. 13 and 14. *Anopheles* (*Kerteszia*) *anoplus*, male. 13. Mesosome. 14. Dorsal lobe of claspette.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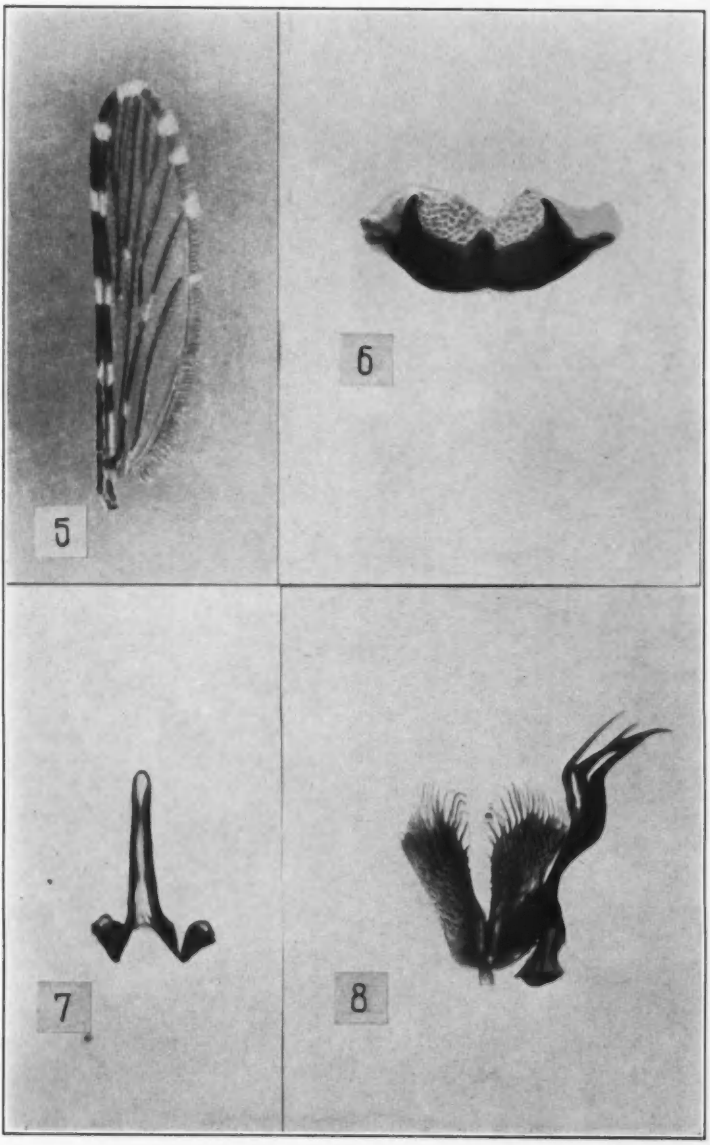
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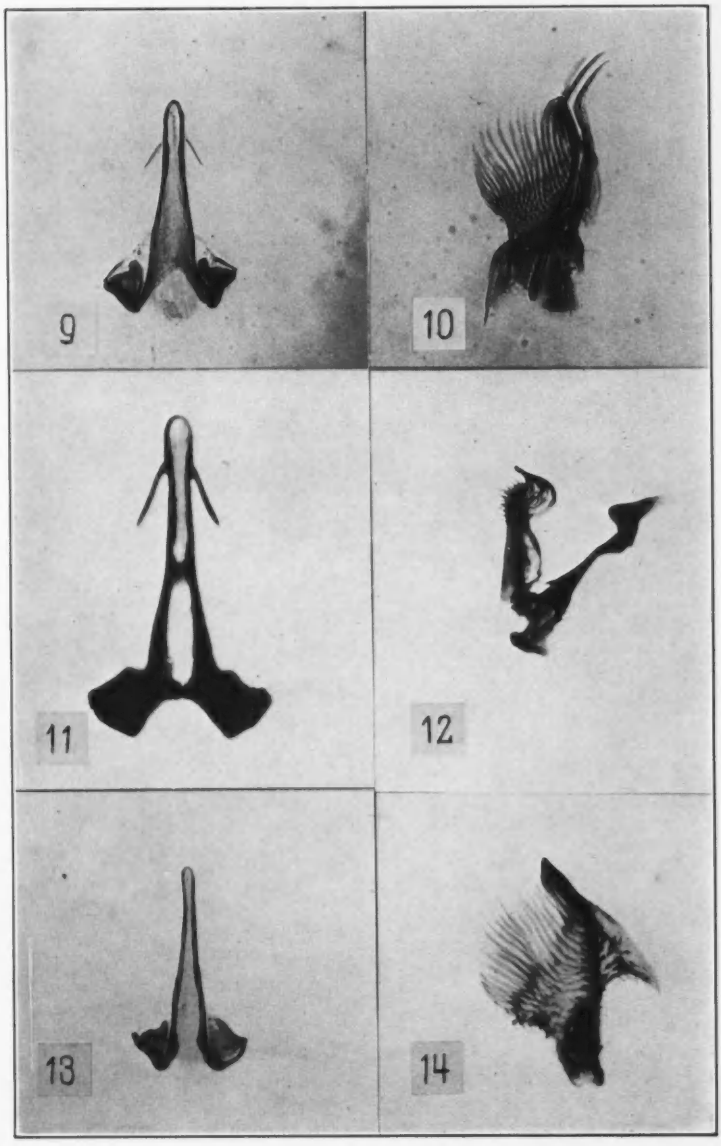
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NEW ANTS FROM OHIO AND INDIANA, FORMICA PROCILIATA, F. QUERQUETULANA, F. POSTOCULATA AND F. LECONTEI, (FORMICIDAE: HYMENOPTERA)

CLARENCE HAMILTON KENNEDY,
Ohio State University,
Columbus, Ohio

AND

CLYDE A. DENNIS,
Tusculum College,
Greenville, Tenn.

The senior author with various graduate students has been actively interested in Ohio ants since 1929. The subject has presented two grave difficulties, the "variability" of the material and the use by myrmecologists of relative terms in practically all published descriptions. A phase of the latter is the apparent distaste of many students of ants for the laborious task of making illustrations. In the following pages we have attempted, where it appeared to be especially needed, a more exact statement of spacial relations, of pubescence, hairs, etc. Contours and outlines we have figured. Our last description is a comparison, but with the second commonest North American ant, available to all American students.

Formica prociliata n. sp.

Holotype, nest queen, from nest No. 1436, Kennedy collection.

Total length 9 mm. (paratype queens 9–10 mm., pinned).

Head, width at eyes, 1.8 mm., at base of mandibles, 1.3 mm., length to tip of clypeus 1.8 mm.

With the general characters of the Rufa Group of Formica as given in Wheeler's key (pp. 387–388, 1913). Head square behind, sides converging below. No hairs on eyes. Frontal carinae less than twice the height of antennal socket; a shallow circular depression in frons on median line below middle ocellus; frontal area pubescent, shining, its upper side a right angle; clypeus without keel, lower edge evenly rounded, lower two-thirds of its convex surface vertically striate. Striate mandibles, 8-toothed. Maxillary palp as long as mandible, 6-segmented. Seen from above, antennal scape sinuate on both anterior and posterior contours; basal segments of funiculus almost as wide as seg. 9, the widest.

Contour of thorax shown in Fig. 1, of petiole in Fig. 9, the latter with acute edge above, squared top and angles (semioctagonal); face and clypeal hairs shown in Fig. 3.

All surfaces smooth and shining except mandibles, clypeus and antennae. All surfaces hairy, the hairs brownish yellow and varying

from a scattered appressed pubescence through intermediate lengths to long shaggy hairs with curled and hooked tips; the shortest of the pubescent type, in length, three times width of an ocellus of the compound eye, the long hairs equalling more than half the height of the petiole.

Hairs distributed as follows: mandibles hairy except on outer basal surface (not drawn in Figs. 3 and 4); antennae densely covered with short appressed hairs; clypeus with many very long hairs along its lower edge and over middle third of its surface some with curly tips equalling clypeus in length. Frontal area with 8–10 minute pubescent hairs. Remaining surfaces of head with pubescent-like hairs the interspaces greater than length of hairs (sparse), much longer and oblique on frons below median ocellus.

Thorax with the longest type of curled hairs on all prothoracic surfaces, metanotum, crest and slope of epinotum, outer and dorsal edges of petiole. Scattered long hairs on inner coxal surfaces and lower mesopleurum. Mesopleurum otherwise with delicate appressed hairs ⅛–1/10 as long and spaced their length apart. Sides of metathorax more densely haired with longer appressed hairs. A tuft of long hairs below insertion of hind wing. Coxae shaggy with long appressed hairs besides the few very long hairs mentioned above. Legs hairy with oblique appressed hairs. Gaster with inconspicuous (at 30x) pubescent-like appressed hairs as on head, but more widely scattered on dorsal surface and more dense (insertions spaced less than length of hairs) on lateral surface of tergites. Sternites densely covered with the long hairs with curly tips.

Color and appearance. Thorax light tan with metanotum seal brown. Head slightly more reddish than thorax, with vertex distinctly red. Abdomen pale reddish brown (darker than head or thorax) with dark brown rings distinct in living queen with distended gaster. Antennae with scape reddish, funicle dark grayish brown. Legs tan as in thorax. (Wings in paratype virgins grayish smoky.) To the unaided eye the queen is a large, reddish brown ant, with shining head and abdomen.

In Wheeler's key to queens of the Rufa Group (p. 392, 1913) the queen keys out to *ciliata* Mayr, but differs in having no long hairs on gular region, few on sides of thorax and coxae and none on dorsum and sides of gaster. She is also larger than *ciliata*.

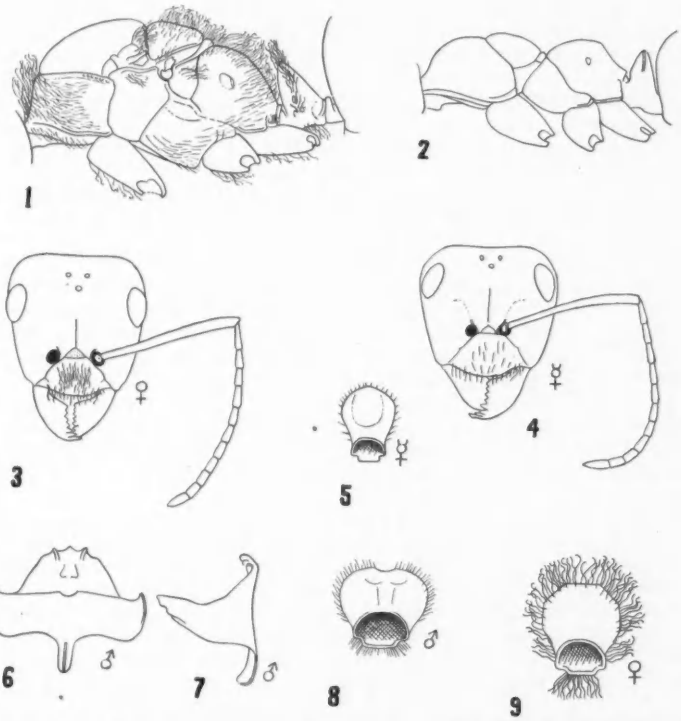
Paratype, major worker, from nest No. 1436, Kennedy collection.

Total length, 8 mm., head, width at eyes, 1.8 mm., at base of mandibles 1.5 mm., length to tip of clypeus 1.9 mm.

Mandibles 8-toothed, clypeus strongly carinate over its middle half, its lower edge slightly angulate. Occiput slightly concave. Eyes without hairs. Frontal area an equilateral triangle, frontal carinae short, one and a half times as long as diameter of antennal foramen, diverging above. A delicate frontal carina reaching two-thirds the distance to median ocellus. Antennal scape from above very slightly sinuate, funicle expanding uniformly to base of its seg. 11. Maxillary palp 6-segmented, as long as mandible.

Contour of thorax shown in Fig. 2, of face and clypeal hairs in Fig. 4; petiole in Fig, 5.

Mandibles finely striate, feebly shining, hairy (hairs not included in Fig. 4). Clyepus shagreened but its lower two-thirds striate half way to each lateral angle. Remainder of body uniformly and finely shagreened giving the worker a very opaque appearance or, to the unaided eye, almost the appearance of a light pruinosity.



Figs. 1–9. *Formica prociliata*, n. sp. 1. Thorax of queen showing distribution of the long curly-tipped hairs. 2. Thorax of major worker, shape only shown. 3. Face of queen showing long hairs on clypeus. 4. Face of major showing clypeal hairs only. 5. Petiole of major. 6 and 7. Subgenital plate (sternite 9) of male. 8. Petiole of male. 9. Petiole of queen. (Figs. 5, 8 and 9 slightly more enlarged than other figures in this article.)

Except mandibles, the entire head, body and appendages covered with a pale yellowish pubescence the hairs of which vary in length from the width of 3 to that of 5 ocelli of the compound eye. On the head the distance between insertions about equals the length of the pubescent hairs. On the thorax they are spaced apart 113 their length, on the

crest of the epinotum and on the gaster they are more dense and overlap. This long and dense pubescence adds to the dullness of this ant's colors.

No long curling hairs as on the queen except an occasional one on tip of gaster. Hairs light brown, appressed on mandibles, numerous (50?); pointed and erect on clypeus (Fig. 4); over anterior surface of pronotum scattered uniformly at spaces equal to their height but dorsal surface of pronotum densely covered with erect hairs slightly inclined forward; a crest of a dozen at posterior edge of metanotum; hairs on crest and upper sides of epinotum at spaces equal to their height. Coxae and trochanters with a few curving hairs. Petiole (Fig. 5) with numerous erect hairs on crest, upper sides and underneath. Gaster with 20–30 long, erect hairs on each sternite and about 12 very long hairs in a circle around Seg. 6. Tibiae with 2 rows of hairs on apical half or apical third of flexor surface.

Color and *appearance*. Head, thorax and petiole pinkish red to the naked eye. Antennae more brownish, infuscated toward tip of funicle, Coxae and legs dark brown. Gaster dead black, appearing grayish because of the long, dense pubescence.

Paratype, minor worker, nest No. 1436, Kennedy collection.

Structure in general as in major worker with the following differences. Clypeus with striations reduced to striately arranged areas of the shagreen. A low but *distinct* mid-frontal carina reaching half way to middle ocellus. Surface and vestiture as in major workers but the erect hairs perhaps slightly less numerous.

(Color of smallest minors usually dark brown.) Of the paratype, head, thorax, petiole and appendages dark brown, slightly lighter on sides of thorax, on the basal half of funicle and lower side of petiole. Gaster brownish black. Colors dull as in the majors.

Intermediate workers, nest No. 1436.

In the next size above the smallest minors, the thorax is lighter but still brown. In larger intermediates (6 mm.) the thorax is usually distinctly red, the head red but infuscated on dorsal surface. Color-change with increase in size is not always correlated with a particular size as some intermediates slightly larger than smallest minors may have distinctly red head and thorax and some slightly less in size than the largest majors may have dark brown head and red thorax.

Allotype, male, from nest No. 2091, Kennedy collection.

Total length 8.5 mm., pinned (fresh and alcoholic material 10–11 mm.). Head, width at eyes 1.6 mm., at insertion of mandibles 0.9 mm., length to tip of clypeus, 1.3 mm.

Head with occipital border straight, ocellar area slightly elevated; upper half of front concave below median ocellus ending below in a circular pit as in queen. Frontal carinae equal in length to diameter of antennal foramen; Clypeus with high narrow carina over its lower four fifths, squarely truncate below. Mandible with a terminal well developed pointed tooth and one or two poorly developed truncate inner teeth.

Petiolar scale shown in Fig. 8, subgenital plate in Figs. 6 and 7.

Thorax at wings with same width as that of head through the eyes. Petiole thick, blunt, its scale ⅔ the height of epinotal slope, convex anteriorly, slightly less so posteriorly; its upper edge, viewed from behind with a narrow, shallow, median notch behind which the dorso-posterior surface slightly concave.

Mandibles coarsely puncto-striate. Clypeus with lower edge rough. Frontal area shining. All other surfaces opaque due to fine shagreen with dull ridges. As in queen the hairs tend to vary from a long pubescence to strong long hairs. On most surfaces, if one is present the other is absent but on the tip of the dorsum of gaster seg. 6 both are present as also on the sternites of the gaster. All surfaces except mandibles and frontal area covered with a long pubescence, individual hairs of which equal in width 4–8 ocelli of compound eye, very diversely distributed, on head short with interspaces equal to or greater than length of hairs, on gaster interspaces ½ or less than the length of individual hairs. Legs and antennae densely pubescent. Long hairs on mandibles and clypeus half as long as clypeus. A ruff of curly-tipped hairs on upper part of front half of pronotum. Plain hairs on edges of propleurum, on lower front angle of mesopleurum, a few on coxae, on crest of mesonotum and crest of metanotum and median areas of epinotum. A dozen or so stiff erect bristles on crest of petiole and others on its ventral surface. Gaster with abundant hairs on ventral surface of each sternite. Posterior edge of tergite of seg. 6 with 14–16 stiff hairs. No hairs on eyes.

Color and *appearance*. Color dull black, genitalia dull brown, legs paler than body due largely to their dense pubescence. Wings pale brownish hyaline.

Type and *paratype material* all from a group of nests on the fruit farm of Will Rofkar, formerly of the Wooster (Ohio) Agr. Exp. Station staff, on Catawba "Island" which is also Catawba Point, eight miles east of Port Clinton, Ohio. The nests are in an open blue-grass-carpeted woods of oak, black walnut, etc., on a rocky limestone ridge one-fourth mile east of the Rofkar residence.

Bottle No. 1433 are workers collected on trails, No. 1434 a nest from which workers only were taken, both collected August, 19, 1934, when the colonies were called to the writer's attention by Mr. Rofkar. August 21, 1934, nests No. 1435, 1436 and 1437, the second with one queen the last with two queens collected by Mark Shellhaas and Kennedy. On July 11, 1935, nest 2089 with 20 nest queens collected by Mary Talbot, Clyde Dennis and Kennedy as also nest 2091 with numerous males and winged queens.

The younger nests were in each case in the shade of a small sapling, later expanding beyond shade to 10 feet in diameter. Galleries under the slabs of loose limestone half buried in the blue grass sod. No craters or mounds. As the original nest

surface tends to become hard, new openings are made on the periphery with the eventual partial abandonment of the central area. Thus the largest nests are 10 feet or more in diameter surrounding a bare center 2–5 feet in diameter where there is little activity, with the newer and more flourishing galleries under the rocks in the surrounding blue grass sod. The outermost openings are completely hidden under the tall grass. Thus the nests die centrally while growing peripherally, a fairy-ring effect.

Poorly developed trails 50–200 feet long, of the major and intermediate workers, radiate from the nest areas. Apparently a ground ant as well as a tree ant. Trailing habits very similar to those of *exsectoides*.

As many as 12 queens collected from one nest area, frequently 2–4 queens in a single six inch chamber. Nests with fully developed virgin males and queens July 11 (1935).

This species resembles *Formica ciliata* Mayr (Wheeler, 1903) of Colorado in the very wooly hairs on the thorax but differs from that species in the absence of such hairs from sides and dorsum of the gaster. This species differs from *F. comata* Wheeler in that the workers are redder. The worker's gaster is wholly black which latter character separates the species from *F. criniventris* Wheeler. It differs from *F. oreas* Wheeler and from *F. oreas comptula* Wheeler in having the long hairs on the thorax of the queen. The only eastern species with which it might be confused is *F. ferocula* Wheeler of Illinois which nests in craters and is more yellow in color and has red at base of gaster. The name, *prociliata*, refers to the fact that the queen is less specialized than the queen of *ciliata* Mayr in having a lesser development of long curly hairs.

Formica querquetulana n. sp.

Holotype, queen, from nest No. 2444, Kennedy collection.

Total length 5.5 mm. Head, width at eyes 1.2 mm., at base of mandibles 0.96 mm., length to tip of clypeus 1.3 mm.

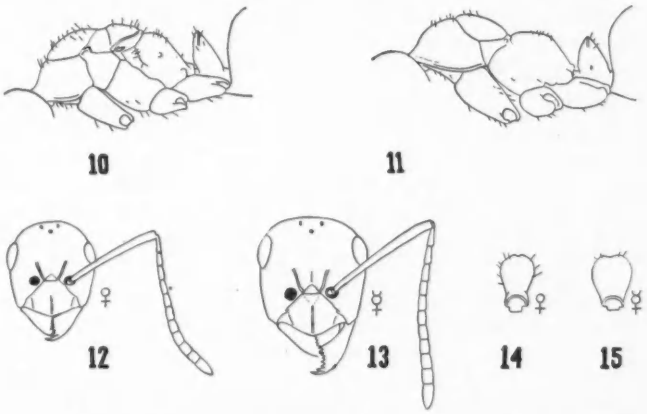
General characters of the Microgyna Group. Head evenly rounded behind, sides nearly straight; front and vertex smoothly convex. Clypeus evenly rounded below, carina a mere line in proper light. Antennal scape with apex twice the diameter of its base, funicle widening to seg. 6 then uniform to tip.

Contour of thorax shown in Fig. 10; face in Fig. 12; petiole shown in Fig. 14.

Head, thorax, legs, petiole and gaster uniformly and delicately shagreened, barely defined at 30 magnifications. Overlying the shagreen

a pubescence of silvery white hairs tightly applied to the surface, length of individual hairs of pubescence 1.5–2 times diameter of ocelus of compound eye; pubescence dense the usual length of a pubescent hair 4 times the distance between insertions of same.

Spiny hairs brownish yellow, linear lanceolate (an occasional hair with truncate tip). Mandibles striate with long pointed hairs on their tips. The following areas with hairs as indicated; clypeus 11, one strong hair in middle of lower edge; frons, 5; ocellar area, 4; one half-sized hair on rear contour of head equidistant from eye and ocellus of its side. No large hairs on gula, antennal scapes or on eyes; propleurum, 6–8 weak hairs; pronotum with 10 along posterior dorsal edge, 1–2 below in front; mesonotum, 20; mesopleurum 12 small hairs; metanotum 12+; epinotal surface 20–25; petiole, 4–5 on either side of crest, lateral edge 4–6. Coxae hairy on anterior and posterior surfaces, each trochanter



Figs. 10–15. *Formica querquetulana*, n. sp. 10. Thorax of the microgynous queen. 11. Thorax of a major worker. 12. Face of queen. 13. Face of major worker. 14. Petiole of queen. 15. Petiole of major. (All figures to same scale. Hairs omitted in Figs. 12, and 13.)

with 1–3 and usually one at base of femur. Flexor surface of tibia with 2 rows of 4–5. Gaster bare on anterior surface of seg. 1 and on lower sides of tergites. Segments of gaster with hairs as follows: dorsal surfaces seg. 1, 35–40, seg. 2, 30+, seg. 3, 25–28, seg. 4, 16+, seg. 5, 10+, those on seg. 5 one and a half times as long as other hairs on gaster. Sternites sparsely haired, hairs variable in length some one and a half times as long as others. The length of average hair on dorsum of gaster is ⅛ of width along middorsal line of pubescent area of gaster seg. 2.

Color and appearance, (30X), thorax and legs a yellowish brown, head slightly darker, mandibles and funicle of antenna dark brown. Wings opaque, a dull smoky brown. Gaster black. Colors dull due to shagreen overlaid with dense very fine pubescence, silvery on gaster less so on

head and thorax. In the field this species was spoken of as the "dirty Formica" because of the dull colors especially in early spring colonies before the more vigorous and more brightly colored workers appeared.

Paratype, major worker, nest No. 2444.

Total length 5.5 mm., head, width at eyes 1.4 mm., at base of mandibles 1.14 mm., length to tip of clypeus, 1.5 mm.

General characters as in the Microgyna Group. Head evenly rounded, sides nearly straight, front and vertex smoothly convex. Clypeus evenly rounded below with a well developed carina its entire length. Funicle of antenna widening uniformly to its seg. 10.

Contour of thorax shown in Fig. 11; face in Fig. 13; petiole in Fig. 15.

Head, except mandibles, thorax, legs, petiole and gaster uniformly and delicately shagreened, barely defined at 30 magnifications. Overlying the shagreen a delicate pubescence of silvery hairs tightly applied to surface: length of a pubescent hair equals diameter of an ocellus of compound eye and 3–4 times as long as distance between insertions of contiguous hairs.

Spiny hairs brownish yellow usually flat, linear, with roundly truncated tips. More sparse than in queen, perhaps due to loss through more active occupation. Mandible striatopunctate with long pointed hairs on apex. The following areas with hairs as indicated: clypeus, 13 (one in middle of lower edge); frons, 4; ocellar area 4 (6 in other paratypes); no hairs on eyes, on rear of head, sides, gular region or on scapes of antennae. Thorax: pronotum 8 on crest, 1–2 on anterior surface; propleurum, 1–2 on anterior surface; mesonotum 3 (6 in other paratypes); epinotal crest 12–18 very short hairs and 4–6 on side above metasternal gland. Procoxa with 2 on anterior and posterior surface each. Middle and hind legs free of hairs on coxae, trochanters and femora. Each leg with 2 rows of hairs on flexor surface of tibia.

Gaster with anterior surface of seg. 1 bare; dorsal surface of seg. 1, 25 (probably 10 lost); seg. 2, 20; seg. 3, 25; seg. 4, 20; seg. 5, 10 twice as long as those on segs. 1–4. Sternites with 5–7 hairs each. Length of hair on dorsum of gaster one-sixth of width, on middorsal line, of pubescent area on seg. 2.

Color and appearance, (dried alcoholic material, 30X). Reddish brown, except dull black gaster, dusky tips of antennal funicle and a slight infuscation of pronotum, of mesonotum and of apex of petiolar scale. Legs and mandibles brown. Colors dull (opaque) due to the dense, tight pubescence overlying the dense, delicate shagreen.

The major workers in the field and in the bottle are distinctly red on head and thorax, more so than even the more mature queens. Dried and to the unaided eye the gaster is a slate gray due to dense pubescence over the shagreen. The majors have no luster or shine except on mandibles.

Paratype, minor worker, nest No. 2444.

Total length 4 mm., head, width at eyes 1.1 mm., at base of mandibles 0.83 mm., length to tip of clypeus 0.9 mm.

Minor worker generally similar to major worker in structure.

Erect hairs as in major except they are shorter in proportion to width and as abundant. Pubescence on gaster similar but on head and thorax more sparse and shorter giving these surfaces a more shining appearance under 30 magnifications.

Color and appearance. General color brown at 30 magnifications but with a slight suggestion of red to naked eye. The head from below the eyes to rear is distinctly infuscated with darker brown. Pro- and mesonotum with dark brown above as also the tip of petiolar scale. Legs dark brown, the hind pair darkest.

Male unknown.

Relationships: This ant is without question in the Group Microgyna of Formica as the queens are no larger than the major workers. It runs in Wheeler's (1913) key (pp. 394–395) to couplet 5 but fits neither division of couplet 5. In this species the petiole is blunt as in division one but the color is a sordid reddish yellow as in division two. The species *nepticula morsei*, *impexa* and typical *microgyna* are eliminated by couplets 1–4. Of the other species (and varieties) only *recidiva*, typical *rasilis*, *spicata*, typical *difficilis* and *consocians* have such dense pubescence on the gaster. *Ricidiva* is more hairy on the legs, *rasilis* (typical) has the posterior border of head feebly concave, *spicata* with more dark brown, typical *difficilis* has base of gaster red as has *consocians*. We have been unable to check this species more closely into the Group *Microgyna*, The name *querquetulana* means pertaining to an oak forest. The nests of this species are usually in dry or well drained soil characterized by various species of oaks.

Described on holotype queen, major worker and minor worker from nest No. 2444 in Kennedy collection. The types in the pinned series of the collection.

The paratype material consists of:

No. 2444 (9 bottles) Kennedy Collection and from the same type colony No. 7–29 (4 bottles) Talbot Collection collected July 11, 1937, by Talbot and Kennedy on second sand ridge north of Angola Road and east of King Road, one mile north of Holland, Ohio. No. 2428 (4 bottles) Kennedy Collection collected by the latter on same ridge 500 feet distant, July 4, 1937. No. 2482 (5 bottles) Kennedy Collection and No. 7–52 Talbot Collection. This nest located by Talbot August 8, 1937, in same area but on sand ridge east of King Road and one-eighth of a mile south of Nebraska Road.

The following nests collected by Kennedy in the high hills of southern Ohio (Adams Co.) in Kennedy Collection No. 156, Poker Hollow on Route 7 east of Peebles, April 19, 1931, No. 328 (3 bottles, nest queens) on top of hill, pasture, above school house east of bridge on Route 41, Peebles to West Union, May 23, 1931, No. 330 second nest on same hill, May 23, 1931, No. 805, same best as No. 328 recollected June 12, 1932. No. 789, Cedar Mill pasture south of West Union, May 24, 1932, No. 2097, (strays) and No. 2099 (outlier nest no queen or brood) Cedar Mill pasture, July 14, 1935.

The type nest, No. 2444, was in pure sand under the edge of a discarded piece of carpet. Immediately under the carpet were irregular shallow brood chambers, below these to a depth of ten inches a dozen or more nearly spherical chambers, one to two inches in diameter widely spaced from each other. Various of the chambers were packed with workers, callows, winged queens and brood.

Nest 2428 was similar but under a withered branch of oak leaves. Nests 328 and 2099 were under the edge of rocks the openings covered with loose trash as with *Formica truncicola*.

The nests west of Holland, Ohio, were in a sandy area, "The Oak Openings" of ecologists, with black oak and many prairie plants. The Cedar Mill nests were in an old pasture at bottom of a deep valley in mixed mesophytic forest. Nest No. 328 was in a dry pasture on the top of a high rocky hill with mixed mesophytic forest in the ravines. Apparently the nests are shallow and have no connection with a water table below.

Formica postoculata n. sp.

Holotype, major worker, from nest No. 215, Kennedy collection.

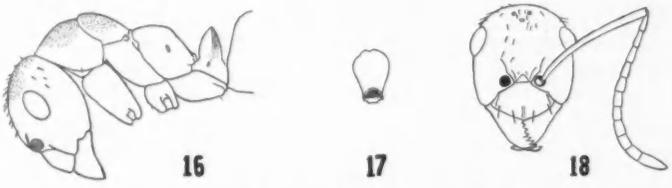
Total length 4 mm. (other paratypes 4.75 mm.). Head, width at eyes 1.4 mm., at base of mandibles 1 mm., length to tip of clypeus 1.6 mm.

Characters of the Fulva and Microgyna Groups, from small size and pubescence probably Microgyna. Head as wide as length to base of mandibles, sides parallel with widely rounded angles above and below, posterior border convex. Clypeal border evenly rounded, clypeal keel incomplete on upper fourth of clypeus, delicate but distinct. From above, front contour of antennal scape nearly straight, posterior contour sinuate, apex twice the width of base, funicle widened uniformly to seg. 7, 8–11 of uniform diameter.

Contour of thorax shown in Fig. 16; of face in Fig. 18; petiole shown in Fig. 17.

Head, body and appendages shagreened, that on head lightly impressed leaving the head surfaces glossy, on thorax more deeply impressed giving a dull surface, on gaster (30 X) shagreen as on thorax but surface more irregular (slightly roughened). Pubescence on head white, pubescent hairs with length 1–2 times diameter of ocellus of compound eye and equal to space between adjacent hairs. Pubescence on thorax the same except three times as long on inner sides of coxae. Pubescence on dorsal surface of gaster three times as long as on head, thinning on sides of gaster to where interspaces are equal to or greater than length of the hairs.

Spiny hairs on head and thorax linear, on gaster with slightly widened lower third, apices sharp or dull or occasionally truncate, color pale brownish. Mandibles striate with long hairs on their tips. The following areas with hairs as indicated: clypeus 4 on lower half (12–14 on some paratype workers); frons, 8 (14 hairs on paratypes); ocellar area with 6; angle of head back of eye 4–6; gular area above middle 4–6; pronotum 6 above; mesonotum 2 above, mesopleurum with 3–4 on lower



Figs. 16–18. *Formica postoculata*, n. sp. 16. Head and thorax of major worker showing the postocular hairs and infuscation. Thoracic hairs omitted. 17. Petiole of major. 18. Face of major.

end (0–1 in paratypes). Epinotum with 3 minute stubs above (0–6 in paratypes). Petiole bare above (occasional worker with 1–2 on or near upper edge. A double row on inner surface of tibiae. Vertical anterior surface of gaster bare, other areas with hairs as follows: dorsal surface, seg. 1, 40–50; seg. 2, 60 plus; seg. 3, 40–50 hairs; seg. 4, 25; seg. 5, 20; those on seg. 5 twice the length of other hairs on gaster. Each sternite with about 10 hairs.

Color and appearance, (30 X) head slightly shining because of lightly impressed shagreen and thin pubescence. Color light reddish brown (30 X) more reddish to unaided eye, lightly infuscated on ocellar area, less so on rear of head. Thorax (30 X) dull pale brown widely infuscated on dorsum of pronotum, and dorsum and sides of mesothorax, the anterior edge of mesonotum edged with pale brown. Antennal scapes, coxae, legs, petiole dull, slightly paler than head, but darker brown than thorax. Antennal funicle lighter than scape, its tip not noticeably infuscated. Infuscation on petiole is heavier on its posterior surface. Gaster a dull, dark brown, seg. 1 suffused with slightly lighter brown on each side of articulation of petiole. To the unaided eye the brown parts are slightly more reddish; in the field, to the collector, the masses of ants appear to be of dull black and red ants.

Paratype, minor worker, nest No. 215.

Total length 4 mm. (other paratypes 3.5 mm.).

General structure as in the major. Dorsal surface of epinotum less arched. Apex of scale of petiole lower than top of epinotum. Shagreen and pubescence as in major but hairs fewer. Those on hind angles of head short, 2 in number and difficult to locate (30 X). Head dark brown above and in front down to between frontal carinae. Antennae, lower face and legs, paler brown. Thorax and petiole dark brown even to absence of pale stripe around anterior edge of mesonotum. Gaster as in major, a brown so dark it appears at first as black.

Male and *queen* unknown.

Described from one nest, No. 215, Kennedy Collection, taken by C. H. Kennedy and Arthur C. Cole, Jr., in grassy pasture on shoulder of high hill facing the Ohio River on the road between Aurora and Rising Sun, Ohio Co., Indiana, May 2, 1931. The nest was in a V-shaped crevice between two large boulders and was covered with trash.

This species keys out to *adamsi* Wheeler (1913, p. 394) but differs from that species in having hairs on the posterior angles of head and a few hairs on the gular surface, also in having little infuscation, if any, of the antennal funiculi. The name, *postoculata*, refers to the location of the group of hairs back of the compound eyes.

Formica lecontei, n. sp.

Holotype. Virgin queen, No. 704, Kennedy collection.

Total length 11 mm. Head, width at eye 2 mm., at base of mandibles 1.6 mm., length to tip of clypeus 2.2 mm.

The queen of this species very nearly identical in gross structure with the queen of *F. subaenescens* Emery and with the queen of *F. subsericea* Say, the most abundant North American Formica, but differing from both in having on head, thorax and gaster a slightly shorter and much more dense, white or silvery pubescence giving it a frosted or delicate pruinescent appearance. The dense pubescence on the head composed of hairs whose length is 1½ times the diameter of an ocellus of the compound eye. The interspaces between insertions of hairs slightly less than the length of a hair. The pubescent hairs slightly longer on cheeks and clypeus. No hairs on eyes. On the thorax pubescent hairs considerably longer, 4–5 times as long as the diameter of an ocellus of the compound eye. On the gaster more densely spaced than on head or thorax, on the dorsal surface the spacing ½–½ the length of individual hairs which are short, equal to twice the diamater of an ocellus, except the fringe of longer pubescence at posterior edge of each segmental band.

Erect hairs on head confined to mandibles and clypeus. On the latter pubescence covers its entire surface above which extend 10–12 long erect hairs among the bases of which on each lateral third and along lower front edge are numerous intermediate more appressed hairs.

Four or five scattered hairs on mesonotum and as many on metanotum. Long hairs on gaster as in *subsericea*.

Color of head and thorax black, of gaster black to the unaided eye, lustrous dark brown at 30 magnifications, with the delicate white frosting of the pruinescence.

Paratype, worker major, No. 704, Kennedy collection.

Total length 7 mm.; head, width at eyes 1.6 mm., at insertion of mandibles 1.3 mm., length to tip of clypeus 2.0 mm.

Pubescence as in queen. Color of head, thorax and gaster black with the delicate frosting of the silvery pubescence. (Gaster more brownish in less mature workers.) Mandibles, antennae and legs dark brown.

Paratype, worker minor, No. 704, as in major worker.

Allotype, male. From nest No. 704.

Total length 11 mm. (other paratype males 12 mm.). Head and thorax black, petiole and gaster dark brown, lighter on segs. 5 to 7. Wings brown. Legs bright lemon yellow. Antennae with both scape and funicle medium brown, no infuscation of antennal tips. Entire body pubescent but pubescence less conspicuous than in queen and workers and on gaster yellowish.

Nesting habits. All nests found have been on stony, sunny slopes in short grass. Nests are apparently started under stones and then may spread to as much as three feet in diameter. Those examined more carefully appear to have a wide shallow layer of brood galleries just under the warm surface. The deeper galleries were not dug out. Nest queens were found in the smaller nests at a depth of 8 inches. This ant was common at Indian Gap.

Material described. One queen and 7 males (pinned collection) taken in Jug Run, Smithfield, Ohio, August 4, 1927. Nos. 696, 700, 702, 703, 704 taken along roadside and in mountain meadow at Indian Gap, 5,000 feet elevation, in fir zone on an outlier ridge of Mount Leconte, on the ridge along the crest of which is the Tennessee-North Carolina boundary. This spot is on the road built along the crest of the ridge from New Found Gap to Clingman's Dome since the collection was made. Collected by Kennedy, September 13, 1931. Nest No. 704 is the type nest from which the described individuals were collected.

We have hesitated to describe this species as it is probably included by Wheeler (pp. 504–505, 1913) as a large form of *Formica subaenescens* Emery. It agrees with *subaenescens* in distribution at high, cool elevations though it was also taken in warmer eastern Ohio at approximately 1,000 feet elevation. It

agrees in type of nest as it is not known to make mounds but spreads a large shallow nest out around a flat stone. It agrees in size with the large sized ants included in *subaenescens* by Wheeler, in the brown wings of queens and males and in the bright yellow legs of the males.

It differs from *subaenescens* in the greater fineness and greater density of the pubescence in *lecontei*, in the pure jet black of head and thorax of all castes and the nearly jet black of the gaster of very mature workers. The male differs in having all parts of the antennae a medium brown (in pinned and alcoholic material). In *subaenescens* the scape of the male antenna is described by Wheeler as being lemon yellow as are the legs.

LITERATURE

Wheeler, W. M. 1903. Extraordinary Females in Three Species of Formica, with Remarks on Mutation in the Formicidae. Bull. Amer. Mus. Nat. Hist. 19 (28): 639–651, 3 figs. (*F. ciliata* and relatives.)

1913. A Revision of the Ants of the Genus Formica (Linne). Mayr. Bull. Mus. Comp. Zool. 53 (10): 379–565, 10 maps. (Monograph.)

1917. The Mountain Ants of Western North America. Proc. Amer. Acad. Arts and Sciences 52 (8): 457–569. (Notes on *rufa* and *microgyna* varieties. Nine new species and subspecies described.)

A GLOSSARY OF ENTOMOLOGY (Smith's "An Explanation of Terms Used in Entomology,") completely revised and rewritten by J. R. DE LA TORRE-BUENO.

This long-awaited revision arrived too late for an extended notice in this issue. It appears to be up to expectations and will receive a fuller notice later. Price $5.00 from the Brooklyn Entomological Society, Brooklyn, N. Y.—C. H. K.

BOOK NOTICES

FRAGMENTS OF ENTOMOLOGICAL HISTORY, Including Some Personal Recollections of Men and Events, by HERBERT OSBORN, pp. i-vii and 1-394, 47 pls. Published by the author. Price, $5.00.

Professor Osborn gives us in his Fragments of Entomological History a picture of his innumerable contacts with the science in America through almost the whole era of the development of the teaching of entomology and the development of official applied entomology. Up to his day entomology had been a haphazard science, mostly taxonomic in nature. He entered the work at the period when a coherent structure began to develop.

One of Professor Osborn's keenest pleasures in life is that of travelling with the main objective of meeting other entomologists and observing first hand the work of such. Regularly every year he takes one or more trips to distant parts of America on each of which he stops at every experiment station and department of entomology along the way not too far off his general route. Various similarly planned trips were taken abroad at greater intervals. We know of no entomologist versed in both teaching and applied entomology who has kept active such broad contacts in America. This is the background of experience which has made possible the store of knowledge set down in the "Fragments." Professor Osborn is one of the few men in point of time and experience who could have given us a comprehensive first-hand knowledge of this field.

Further, Professor Osborn has always been interested in the history of entomology. Even before this volume was planned he had made an extensive collection of portraits of entomologists with numerous notes on important phases of the development of the science in America and abroad which was for use in the work of the department at The Ohio State University. The book is the happy product of these opportunities and interests.

Professor Osborn enjoyed entomology and enjoyed entomologists. The volume carries this tone of pleasure all through it, starting with the dedication: "To my entomological friends, former students and associates, with many fond recollections of stimulating associations through years that are gone, this volume is dedicated with sincere appreciation and affection." It is a stimulating volume of pleasant memories, prophetic of the soundness and stability of the science.

The volume has been planned to treat lightly the various phases of entomology treated in recent works on its history by Essig, Weiss and Howard. It takes up in considerable detail mid-west entomology, the work of experiment stations, and the development of the teaching of the science in the colleges and universities of America. One hundred pages are devoted to brief "Personal Sketches," a "Who's Who" of American entomology. One of the important parts of the "Fragments" is made up of forty-four plates of portraits, the majority of which carry nine portraits each. To any one familiar with the difficulties in the reproduction of photographs of all degrees of intensity and all types of background, the arrangement of these and their excellent reproduction, nine to a plate, speaks well for the skill of the author and that of the engravers, Bucher Engraving Company. Backgrounds had to match under the engraver's camera. It is an unusually fine set of plates of this type.

The twelve chapters cover the following subjects:

I. Early Steps in Entomology; II. The Nineteenth Century; III. Federal Service in Entomology; IV. State Entomologists, Inspectors and Quarantine Officers; V. Experiment Station Entomology; VI. Entomological Instruction in Colleges; VII. Entomological Societies; VIII. Entomological Publications; IX. Personal Sketches; X. Insect Collections; XI. Some Regional Notes; XII. Miscellaneous Notes; Plates; Index.

The volume is more impersonal than we had hoped it might be. One of the pleasures of teaching at Ohio State University has been that of Professor Osborn's discussions of immediate problems in the light of his personal experiences. Not reminiscences in the usual meaning of the term, as Professor Osborn had little

time for such, but side lights on the abilities and personal characteristics of the men who have made the science in America: Side lights on character and habits of thought that explained why entomological history has been such as it has.

It is a pleasant book written in an easy style. We recommend it to all entomologists. The reader gets a picture of a science built on love of the subject and personal sacrifices which will cheer and encourage him in his moments of depression from the hard labor involved and the difficulties encountered on every hand.

A word for Spahr and Glenn, the printers, who have taken almost as much interest in the production of the volume as has the author himself. It is well bound, is on excellent paper and is altogether a fine example of the best press work.—C. H. K.

ECOLOGICAL ANIMAL GEOGRAPHY. An authorized, rewritten edition based on Tiergeographie auf oekologischer Grundlage, by RICHARD HESSE. Prepared by W. C. ALLEE and KARL P. SCHMIDT; pp. i-xiv and 1-597, 135 text figures. 1937. Published by JOHN WILEY & SONS, INC., New York, and CHAPMAN & HALL, LTD., London. Price, cloth, $6.00.

As stated on the title page this large volume is a translation, with some rewriting, by the translators, of "Tiergeographie auf oekologischer Grundlage" (1924) by Professor Richard Hesse, of the University of Berlin. Professor Hesse, in his edition of 1924, made the first important European attempt to place animal distribution solidly on a basis of ecological principles. It was a publication by a master.

The present translation with some changes in the text to line the thought up with recent work opens this volume to American readers.

Hesse's point of view is that of the world distribution of animal life. The present science of ecology has grown up in recent years (since Cole's discovery of succession) as an ecology of narrowly limited associations, almost an ecology of species. Hesse has attempted to apply principles discovered in modern ecological studies to the problems of world distribution. His work is from the broadest point of view of that of any of the more general books on animal ecology. As the first fairly successful work in this larger field, the original German edition had gaps in what otherwise might have been a more coherent presentation of the subject, if the knowledge had been available at that time. Various of these obscure areas have been cleared by the rewrite of the translation.

Because of the better philosophical approach when the subject of ecology is taught from a broader or even world point of view, teachers of ecology have tended in this direction in recent years. The work by Hesse more nearly fills the philosophical needs of the teacher than have some of the works from a narrower point of view. Of the two translators and rewriters, Professor Allee, of Chicago University, is the experienced teacher of animal ecology while Doctor Schmidt, of the Field Museum of Natural History, is the ecologically minded world traveller, a happy partnership to catch the point of view of the original author.

The volume is of further value in that it collects and classifies much scattered European literature on the subject of animal ecology.

The subject matter is presented in twenty-eight chapters which are arranged in four general parts: A. The Ecological Foundations of Zoogeography, which treats of such things as conditions of existence, effect of environmental selection on distribution, classification according to the general characteristics of the environment, barriers and means of dispersal, geographic isolation, influence of extent of range and biotypes and biocoenoses. B. The Distribution of Marine Animals, which covers physical conditions, chemistry of the sea, biotic divisions of the ocean, lenthal, pelagial, abyssal and geographic divisions of the pelagic communities of the sea. C. The Distribution of Animals in Inland Waters, A Phase of Limnology; environmental factors, communities in running waters, in standing waters, in other inland waters. D. The Distribution of Land Animals; ecological factors, forest communities, communities of dry, open lands, of swamps and shores, alpine animals, animal life of Polar Regions, island communities, subterranean animal life, the effect of man on other animal life.

The book is solidly bound in linen and printed on well spaced, clear type on heavy white paper.—C. H. K.

THE HISTORICAL DEVELOPMENT OF INSECT CLASSIFICATION, by H. F. WILSON and M. H. DONER. pp. 1-133, 27 diagrams. Quarto, linen-bound photolith. 1937. Published by JOHN S. SWIFT CO., 105 S. 9th St., Saint Louis, Missouri. Price, $4.50.

On opening the package containing this book we had the usual moments of depression on realizing that another volume on entomology had appeared in the photolith process.

On reading it we wholly forgot that it was not in the highest level of the printer's art. (It is in fact the best example of photolith we have seen to date.) It brings those dim names of the founders of entomology out of the obscurity of the past and gives us clear-cut pictures of their contributions to the science. We had thrill after thrill on reading, very much as we have imagined a spiritualist must enjoy under the spell of a well-planned seance. As entomology was almost wholly taxonomic up to the middle of the past century, "The Historical Development of Insect Classification" stands as our most complete history of entomology from the Greek period up to the modern trend into other fields. A biographic paragraph is given on the life and works of each author whose work on classification is discussed, a grand total of 219 short biographies of biological philosophers, zoologists and particularly entomologists. As a history it is per force a narrow presentation as the thought has to adhere to the classification of insects.

The text is divided into seventeen chapters: I. Introduction; II. "Habitat" Systems; III. Wing Systems; IV. Transformation Systems; V. Maxillary Systems; VI. "Circular" Systems; VII, Classification on Embryological Characters; VIII. System of Oken; IX. Classification on Cephalization; X. Classification on Pupa; XI. Classification on Segmentation; XII Classification on Thorax; XIII. Phylogenetic Systems; XIV. Miscellaneous Systems; XV. Apterous Insects; XVI. Orthopteroid Insects; XVII. Neuropteroid Insects. References not cited in Text. Index to Writers. Index of Entomological Names.

One of the outstanding excellencies of the volume is its organization. It must have taken a great deal of conscientious effort to organize such miscellaneous material into its present form. It is a summary of a field for which we have craved a digest and summary for a good many years. Further, it brings more names with some facts of their education and activities into the published records of the history of entomology.

We recommend the volume to all interested in the history of entomology. As to photolith: it is an excellent example of this new process. Perhaps we shall get used to seeing it.—C. H. K.

NIPPON KONCHU ZUKAN, Incongraphia Insectorum Japonicorum, by twenty-six authors. 2241 pages of text + 250 pages of indices, etc., 4000 text figs., 24 colored plates. Half leather octavo. 1932. Published by HOKURYUKAN, Tokyo. Price, postpaid, about $7.50.

This remarkable work came to us in our collection of items which figure or discuss Odonata. We paid for our copy, nevertheless such an unusual volume deserves a notice in the ANNALS. Our student, Mr. Shin Foon Chiu, has graciously given us a translation of the preface and postface. We find no difficulty in reading the more than 4000 beautiful illustrations and their Latin legends. The introductory preface and postface by the "Representative of the Authors" states the project as follows:

"In June, 1927, the "Incongraphia Animalium Japonicorum" was published by the co-operation of twenty-two zoologists in this country. Different species of animals were described in that book which has been extensively used as an important reference by people interested in biology. It is regretful that only the representative species of insects, which occupy the greatest portion of species in the animal kingdom, were described. In August, 1927, incidentally I met Dr. Esaki in a hotel in London. We discussed the incompleteness of the Japanese insect catalogues and realized the importance of the outcome of a comprehensive work on this field."

"It is fortunate that the publisher, Hokurykan, had kindly consented to publish this volume as a sister book of the "Iconographia Animalium Japonicorum." Accordingly a meeting of the editors was called, plans were decided

upon and carried out. I am very grateful to all the authors and many zoological draftmen: without their help this work would never have been accomplished.

"I am indebted to the publishers who did their best in the printing of this book."

"It is hoped that this book, along with "Iconographia Animalium Japonicorum" will be a great contribution to the fields of entomology and zoology in Japan."

"This work is not complete. It is not the ideal work of the authors, but we have done our best in the limit of time and capacity."

Each page has two columns. The upper half of each column carries a stippled drawing of the insect while the lower half carries fifteen columns of Japanese text. The illustrations are excellent and large enough (2¼ x 1½ inches) to carry specific detail. A mere review of the pictures gives one a cross-section of the Japanese insect fauna which is surprisingly like our own in the genera represented. A long section at the back is devoted to illustrations of immature forms as are also seven of the twenty-four colored plates. It is indexed in both Latin and Japanese. There are no keys. It is a picture-book arranged taxonomically. The binding is a very strong one of half leather.

Among the twenty-six authors who have contributed we find such names as Esaki, Kuwana, Oguma, Shiraki, Takahashi, Uchida, and Yuasa, with other names equally distinguished but less well known to American entomologists. The work reflects not only the high level of Japanese science, but also the artistic ability of Japan. It is a remarkable volume in authorship and handicraft.

—C. H. K.

CATALOGUS COLEOPTERORUM JAPONICORUM, Pars 1, Buprestidae, pp. 1–26 (180 species), 1936, Pars 2, Lucanidae, pp. 1–11 (52 species), 1936, Pars 3, Passalidae, 2 pp. (5 species), 1936, and Pars 4, Paussidae, 2 pp. (7 species), 1937, small quarto, by Y. Miwa and M. Cûjô. Published by the Formosa Entomological Research Institute. 3-chome, Sakaemachi, Taihoku, Formosa.

This is a straight species catalogue in the Latin alphabet which makes it useful to all western coleopterists. The four parts in hand are paper bound and are well printed on an excellent soft paper. As planned there will be 103 parts on Coleoptera, one for each family. The purpose and scope of the work are indicated by the author's preface which has been translated for us by our student, Mr. Shin Foon Chiu. "Accurate catalogues are essential to taxonomists and collectors. A detailed catalogue on all orders and families of Japanese insects including the distribution, literature citations and Japanese names is very desirable."

"Heretofore catalogues of such nature are scattered, limited in circulation and not easily accessible. This seems to be unsatisfactory to us; we, therefore ask all specialists to publish their accurate catalogues. . . . The present paper is the beginning of the series."

"The Order Coleoptera has been taken up by Messrs. Miwa and Cûjô. It is hoped that more papers on this order will be published. It should be understood, however, that this catalogue will not be ended with the Coleoptera. Other orders will be taken up."

This catalogue is a great undertaking. Messrs. Miwa and Cûjô are very productive workers on the Coleoptera which promises well for the project. A good catalogue always injects new life into the research in any taxonomic field. We wish the originators of the Catalogue success.—C. H. K.

ANIMAL COMMUNITIES IN TEMPERATE AMERICA, As Illustrated in the Chicago Region, a Study in Animal Ecology, by Victor E. Shelford. Pages i-xiii and 1-368, 306 figs., 9 diagrams, 67 tables. Second Edition, 1937. Published by University of Chicago Press. Price, $3.00.

This volume appeared first in 1913 as Bulletin No. 5 of the Geographic Society of Chicago. There has been such a demand for it by students of ecology that it had long been out of print and its price in the second-hand book trade had risen to as much as fifteen dollars a copy when it was decided to publish a second impression. We quote from the preface of this second edition:

"The second impression of this book is unchanged except for the correction of typographical and clerical errors. An annotated Bibliographical Appendix (pp. 337–341) has been added which will enable the reader to go on with the subject. The community nomenclature has changed materially in the twenty-five years which have elapsed since the book was written. These changes are, however, not serious and it has been possible to provide for the correction of them in a table" (p. 337).

The continued usefulness of the book appears to lie in the fact that it presents a fairly detailed picture of animal distribution in a small area but one which is representative of northeastern America in general. All forms of habitat are represented from aquatic to mature land types. The work is of further interest in that it presents the ecological distribution of animals over an area which at the time of the appearance of the First Edition had been thoroughly studied from the point of view of plant distribution and plant successions. Thus the book is a basic document for all students of animal ecology in temperate America.

The cover is linen, the binding loose enough for easy and hard usage.

—C. H. K.

NEARCTIC COLLEMBOLA OR SPRINGTAILS OF THE FAMILY ISOTOMIDAE, by J. W. Folsum; pp. 1–144, 39 plates, Bulletin 168, United States National Museum. Price, 30 cents from Superintendent of Documents, Washington, D. C.

We do not often give a notice to a routine Federal publication but this is by one of the Charter Members of our society, who died last September. Also it is on Collembola, a group in which he was particularly interested throughout his entomological career.

This monograph is one based on a study of type material and covers all the known North American species of the Family Isotomidae. Of the 66 species treated 28 are described as new and 21 species are Holarctic in distribution.

Through a certain loss of control in recent summers by the reviewer over his environment he has attempted a study of Ohio ants, said by some to be the most difficult group taxonomically of all insects. During this period of travail he has had impressed on his mind the fact that the soil and every damp object in contact with it supports a remarkably large fauna of Collembola. This group forms an almost virgin field in American entomology as only in recent years have many entomologists gotten down to even such small things as ants, leafhoppers and midges. Collembola are in size as far below these intermediate sized insects as ants, leafhoppers and midges are below the larger beetles, dragonflies and Lepidoptera. This field of minute insects, which, though small, occur in myriads is still virtually unexplored in America. Folsom was a man of broad vision who saw the great open spaces in our science and who has helped start work in these less obvious but very vital fields. Collembola have probably been on the earth, very much as at present in myriads, since the dawn of insect evolution and will probably still fill the soil in that twilight of organic evolution after the showy butterflies, beetles, dragonflies, etc., have passed, ages after man and land vertebrates have chilled down to extinction.

The Collembola are an open new field for study but only for those interested workers who do not get cold feet when they have to take off their coats and roll up their sleeves in difficult work.—C. H. K.

KRITISCH HISTORISCH OVERZICHT DER ACAROLOGIE, by A. C. Oudemans. Third section, vol. C., 1805–1850. Tarsonemini Can. & Fanz. 1877. Stomatostigmata Oudms. 1906. Eleutherengona Oudms. 1909. Pages 799–1347; 225 text figs. 1937. Published by E. J. Brill, Leiden, Holland. Price, paper bound, with vol. B., 15 guilders; cloth bound, 17 guilders.

In the March issue of the Annals, 1937, we gave an extended notice of this work, covering the first two sections and vol. A of section three. This volume continues the resumé of the literature concerning the groups indicated in its title. As with the preceding volumes it reproduces the numerous illustrations in the literature reviewed.—C. H. K.

NEW PUBLICATIONS

CURRENT TITLES FROM BIOLOGICAL JOURNALS

This is the title of a very new bibliographic journal which publishes only the tables of contents of current biological journals. Its object is to bring to the attention of its readers the titles and references of articles on subjects of interest without the reader having to browse through the great mass of current literature. Thus the time usually consumed in handling current biological literature is cut down. It takes the subscriber no farther, as no note or abstract of the contents is given.

The journal began, Vol. 1, No. 1, in May, 1937. It is monthly and the subscription price for Nos. 1–8, Vol. 1 (May to December, 1937) is one dollar and fifty cents. The number before us (June) is 74 pages and covers the contents of 65 journals. This issue is devoted largely to medical and physiological literature. So far the journals covered are North American and European excepting those of Slavic countries.

The printing (?) is by the photolith process so that the typography is very irregular. It is a mixture of original tables of contents and typewritten tables.

We are not wild over another journal of this type, particularly as we are reminded that we forgot to mail the Editor the table of contents of the June issue of the ANNALS. It is another odd job out of routine for each editor of a biological journal. The Editor is Prof. L. R. Kuhn, Ricketts Laboratory, University of Chicago. The address of the journal is 5603 Drexel Avenue, Chicago, Illinois. Price of the partial volume (Vol 1) of 8 numbers (May-December, 1937), $1.50.—C. H. K.

ENTOMA

This paper-bound volume of one hundred forty-four pages is a directory of sources of supplies for men in applied entomology. It contains lists of companies selling specific chemicals (pp. 27–75), of companies selling equipment (pp. 75–80), selling machinery and supplies (pp. 80–84), etc. Pages 100–142 carry advertising. The Managing Editor is Professor C. C. Hamilton, Rutgers University, New Brunswick, New Jersey, from whom copies may be had; price, domestic, $0.75; foreign, $1.00. For the active worker in applied entomology this is a valuable guide in the purchase of supplies. It has reappeared in this further edition under pressure of this very necessity. The edition is financed by advertising and by the sale of copies.—C. H. K.